



Predictors of Exercise Adherence and Weight Control: An Application of Self-Determination Theory

Dissertação apresentada com vista à obtenção do grau de Doutor em
Motricidade Humana, Especialidade em Saúde e Condição Física

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Para:
João, Josefina, Bruno e pequena/o “ervilha”

Para:
Todas as mulheres de PESO que participaram no programa

Table of Contents

Abstract.....	7
Acknowledgements.....	11
CHAPTER 1	
Introduction to the Thesis.....	15
Overview of Research Goals.....	18
List of articles, books and conference presentations/abstracts as first author.....	21
CHAPTER 2	
General Introduction.....	27
Overweight and Obesity.....	28
The definition of obesity.....	28
Obesity's causes:	
a mismatch between physiology and modern environment?.....	29
Epidemiology of overweight and obesity in Europe and Portugal.....	31
Physical and psychological consequences of obesity.....	32
Treatment and long-term outcomes.....	36
Physical activity and long-term weight control.....	39
Mechanisms of action.....	42
The problem of long-term adherence.....	43
The need for new research approaches.....	44
Research Background: mechanisms of intervention' success.....	46
Mediators of treatment effects: intervening causal variables.....	48
The importance of theory to practice.....	52
Self-determination theory as a theoretical framework.....	55
The sub-theories of SDT and their conceptual bounds.....	57
References.....	68
CHAPTER 3	
A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: rationale and intervention description.....	80
Abstract.....	81
Background.....	82
Theoretical rationale.....	83
Self-determination theory and motivation for health behavior.....	83
Self-determination theory, exercise and weight control.....	87
The Self-determination theory model for maintained behavior change.....	90
Methods.....	92
Study design.....	92

Recruitment.....	92
Intervention.....	93
Measurements.....	100
Sample size and power.....	103
Discussion.....	104
References.....	106
CHAPTER 4	
Using self-determination theory to promote physical activity and weight control: a randomized controlled trial in women.....	112
Abstract.....	113
Introduction.....	114
Method.....	118
Results	129
Discussion.....	135
References.....	140
CHAPTER 5	
Helping overweight women become more active: need support and motivational regulations for different forms of physical activity.....	146
Abstract.....	147
Introduction.....	148
Method.....	154
Results.....	164
Discussion.....	171
References.....	178
Footnote.....	185
CHAPTER 6	
Exercise autonomous motivation predict 3-Year weight loss in women.....	186
Abstract.....	187
Introduction.....	188
Method.....	191
Results	199
Discussion.....	205
References.....	211
CHAPTER 7	
General Discussion.....	216
Overview.....	217
Summary of main research findings.....	219
Understanding success and failure in promoting long-term behavioral change in the field of obesity management.....	224
Current weight loss attempts: Problems with actual motivational targets.....	224
Weight-loss: outcome or process?	226

Table of Contents

Controlled and self-determined regulations and the question of rigid vs. flexible approach to change.....	228
Autonomous and controlled self-regulations: the issue of creating versus depleting energy for action	230
The role of well-being (fostered by autonomous-regulations) as helping long-term behavior change.....	233
Weight-loss interventions: a continuous care reality?.....	235
Practical implications and future directions: autonomously motivated weight-loss, is it possible?.....	238
The importance of fun, enjoyment, challenge.....	238
Finding other directions: values and self-actualization.....	239
Limitations and future research directions.....	242
Summary.....	246
References.....	247

APPENDICES

Other articles (in Portuguese language) published within the context of P.E.S.O	254
Abstracts of presentations (oral and poster) related to the Thesis.....	302
Questionnaires used in the Thesis.....	312
Health Care Climate Questionnaire.....	313
Self-Determination Scale.....	314
Treatment Self-Regulation Questionnaire.....	315
Intrinsic Motivation Inventory.....	317
Locus-of Causality for Exercise.....	318
Self-Regulation Questionnaire-Exercise.....	319
Motives for Exercise II.....	320
Lifestyle Physical Activity Questionnaire	322

Tables and Figures

Tables

Table 1. (General introduction): Examples and descriptions of the quality of motivation.....	63
Table 1. (Study II): Baseline characteristics.....	129
Table 2. (Study II): Between-group comparison for psychosocial and exercise.....	132
Table 1. (Study III): Composite Reliability (CR), Average Variance Extracted (AVE) and correlations of factors in measurement model	167
Table 2. (Study III): Indirect effects in the structural model.....	169
Table 3. (Study III): Tests of mediation in the structural model.....	170
Table 1. (Study IV): Composite Reliability (CR), Average Variance Extracted (AVE) and correlations of factors in measurement model.....	201
Table 2. (Study IV): Structural model, indirect effects and tests of mediation.....	204

Figures

Figure 1. (Study I): Model describing internalization and human motivation.....	85
Figure 2. (Study I): The Self-determination theory model for maintained behavior change.....	90
Figure 3. (Study I): Relations between psychological needs and motivational styles from SDT and the core principles from motivational Interviewing.....	99
Figure 1. (Study II): CONSORT diagram.....	119
Figure 2. (Study II): Intervention modules implementation.....	121
Figure 3.(Study II): Weight change during the first year.....	133
Figure 4. (Study II): Changes in self-regulation for exercise at 4 and 12 months.....	135
Figure 1. (Study III): Partial least squares model.....	168
Figure 1. (Study IV): Structural model with parameter estimates.....	20

Abstract

The present Thesis was set within a longitudinal randomized controlled trial, consisting of a 1-year theory-based behavior change intervention and a 2-year follow-up period with no intervention. This trial included 239 overweight or obese women (age: 37.6 ± 7 y; BMI: 31.5 ± 4.1 kg/m²) who were premenopausal and free from identified disease. The main intervention was designed to increase physical activity and internal motivation, following self-determination theory (SDT). While tested before for other health behaviors with promising results, SDT had never been previously applied to weight management in long-term, controlled designs. Thus, the four studies comprising this Thesis were designed to provide a comprehensive analysis of how a theory-based intervention, implemented to affect specific theory-based mediators, would impact exercise adherence and body weight change both in short and long-term, from a SDT perspective.

After a complete description of the study protocol, theoretical framework, and main intervention strategies (study 1), study 2 showed that the intervention was successful in affecting theory-driven mediators, physical activity, and weight change at 12 months (intervention's end), demonstrating that the socio-contextual characteristics advanced by SDT are amenable to manipulation, and revealing the potential utility of SDT to shape behavioral interventions targeting the promotion of physically active lifestyles and weight-change.

Studies 3 and 4 searched for a more in-depth understanding of the dynamics of exercise motivation by exploring and testing mediational models aimed at outlining theory-based mechanisms and their impact on different types of physical activity at intervention's end (study 3), and on long-term behavioral exercise regulations and physical activity (24-month) and 36-month weight change (study 4). Convergent with previous research, but extending it into the context of a randomized controlled trial, these studies indicated that perceived need-

supportive health care climate, psychological needs for autonomy and competence, and intrinsic motivation mediate the effects of the experimental treatment climate on structured exercise behavior. Furthermore, these variables rested within the causal path of long-term weight loss, providing evidence from a link between experimentally-increased autonomous motivation, long-term physical activity adoption, and 3-year weight management.

This application of SDT to physical activity and weight management provides experimental evidence that an autonomy-supportive context facilitates the internalization of regulatory processes, particularly through its effect on exercise-related constructs, which in turn promote long-term positive behavioral and clinical outcomes in overweight/obese women.

Keywords: Obesity, Physical Activity, Self-Determination Theory, Randomized Controlled Trial, Mediators of Change, Long-term

Resumo

A presente tese foi desenvolvida no contexto de um estudo longitudinal, controlado e com distribuição aleatória, configurando uma intervenção comportamental teoricamente sustentada, com a duração de um ano, seguida de dois anos de *follow-up* (sem qualquer intervenção). Este estudo envolveu 239 mulheres com excesso de peso ou obesidade, pré-menopausicas e sem patologia diagnosticada. O programa de intervenção foi desenhado de acordo com os princípios base da teoria da auto-determinação (TAD), visando sobretudo o aumento da motivação intrínseca para a actividade física, procurando-se promover a sua adesão a longo prazo. Apesar de este enquadramento conceptual já ter sido testado com resultados promissores na promoção de vários comportamentos de saúde, não há relato de um teste experimental, com avaliações no longo prazo, da TAD no âmbito do controlo do peso. Os 4 artigos que constituem esta tese, no seu conjunto, foram desenhados para permitir a análise do modo como uma intervenção teoricamente sustentada, desenhada e implementada para ter efeito em variáveis-alvo mediadoras, poderá influenciar a adesão ao exercício e a alteração do peso corporal, tanto no curto como no longo prazo.

Partindo de uma descrição pormenorizada do protocolo experimental, das principais estratégias de intervenção e do racional teórico que as sustenta (estudo 1), o estudo 2 veio demonstrar que, 1 ano após o seu início, a intervenção parece ter sido bem sucedida na promoção de actividade física e perda de peso, tendo exercido influência positiva ao nível das principais variáveis-alvo mediadoras (por comparação com o grupo de controlo). Este estudo evidenciou a possibilidade de manipulação experimental das principais características sócio-contextuais identificadas pela TAD como fundamentais na promoção de estilos de vida activos, compatíveis com a eficaz gestão do peso.

Os estudos 3 e 4 representam a passagem do estudo do impacto da intervenção para a procura de entendimento dos principais mecanismos motivacionais envolvidos. Com recurso ao teste de modelos mediacionais, procurou-se estudar o efeito diferenciado das variáveis-alvo identificadas pela TAD na adopção de diferentes tipos de actividade física um ano após o início da intervenção (estudo 3), bem como o papel das referidas variáveis na adesão continuada à actividade física (*follow-up* 2º ano), e alteração do peso a longo prazo (*follow-up* 3º ano). De forma congruente com investigações anteriores, mas estendendo-as a um enquadramento experimental e controlado, os resultados encontrados sustentam a percepção de um clima de suporte à satisfação das necessidades psicológicas básicas (autonomia e competência), e a motivação intrínseca, como mediadoras dos efeitos produzidos pela intervenção na adesão à actividade física estruturada. Estas variáveis funcionaram também como mecanismos associados ao envolvimento continuado em actividades físicas (dois anos após o início da intervenção) e controlo do peso a longo prazo (3 anos após o início da intervenção).

Com base nos resultados encontrados, esta aplicação da TAD à promoção da actividade física e do controlo do peso fornece evidência experimental de que um clima de suporte ao desenvolvimento de autonomia e competência pode facilitar a internalização de regulações motivacionais mais autónomas para a actividade física, as quais se constituem como facilitadoras de mudanças comportamentais importantes e com relevância clínica, em mulheres com excesso de peso ou obesidade.

Palavras Chave: Obesidade, Actividade Física, Teoria da Auto-Determinação, Estudo Controlado com Distribuição Aleatória, Mediadores da Mudança, Longo Prazo.

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Esta é a única secção da presente Tese escrita em Português. E a razão é simples. Ela não exprime factos ou evidência científica, mas afectos. E a linguagem dos afectos já é difícil de se expressar em palavras, quanto mais numa língua “estrangeira” (e por isso talvez mais “fria” e distante). Esta é uma tese sobre pessoas, sobre os “mecanismos motivacionais” que podem estar na base das mudanças que conseguem implementar (ligadas à actividade física e ao controlo do peso), mas é, também ela, o resultado de um processo envolvendo muitos “mecanismos” que só produziram resultados graças a um conjunto alargado de pessoas. Muitas vezes, nesta tese, se defende a importância da identificação das variáveis afectas aos resultados visíveis. Também na vida (no tal campo dos afectos) acredito que assim deve ser. Muitas vezes me ocorre pensar que as pessoas importantes para nós “sabem que o são”, mas... talvez nem sempre seja assim. O risco é sempre o de não se ser suficientemente “justo”, inclusivo, de não se chegar a todos, de não se ter a palavra certa (...é tão mais fácil expressar afectos sem recorrer à palavra), mas que isso não nos demova de tentar.

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CHAPTER 1

Introduction to the Thesis

“Why we do what we do?” is the title of a pioneering book pertaining to the understanding of self-motivation, by Edward Deci, one of the founding fathers of self-determination theory (SDT). This simple, yet profound question (and maybe impossible to answer in absolute), provides the perfect context to introduce this Thesis. This brief preliminary section aims at explaining why the author “did what she did” in terms of this document’s internal structure, logic, and organization.

This Thesis was set within the context of a large prospective, experimental, controlled study, involving a 3-year weight loss and weight maintenance lifestyle theory-based intervention. This randomized controlled trial, called the P.E.S.O. II study (Promotion of Exercise and Health in Obesity) was conducted at the Faculty of Human Kinetics between 2005 and 2009. In general terms, this Thesis was set to address two main goals: i) to describe and assess the impact, on the short- and long-term, of the P.E.S.O intervention on physical activity and exercise, body weight and composition, and on SDT-based motivational and self-regulatory constructs; ii) to identify and describe the theoretically-based mediator variables associated with sustained physical activity participation and long-term weight control.

The core of the present Thesis reflects a collection of 4 research articles published, in press, or submitted for publication in peer-review journals with an established ISI Impact Factor. Although the option for a Thesis based on independent articles has clear advantages, it is not without problems, namely an increased risk of repetition. As such, and to avoid redundancy, the structure of the present document follows these principles:

- 1) A general introduction (chapter 2) was written, aiming at presenting an overview of the topic and build the foundations on which the empirical chapters were based, including a selected review of the evidence pertinent to the main research questions. In other words, it was written to introduce the conceptual and theoretical underpinnings that inform the research

objectives of the four studies presented in this Thesis, responding to the “whys” of: i) the chosen population (overweight and obese women); ii) the targeted behavioral outcomes (physical activity and weight control); iii) the importance of the chosen research design (RCT studying mechanisms of long-lasting behavior change) and; iv) the adopted theoretical framework (SDT).

2) Following the general introduction, the first article (chapter 3) is presented. This article details the study protocol and describes most methodological aspects of the Thesis, many of which are common to the four studies (e.g. study design, recruitment, randomization, intervention principles and strategies, measures, statistical power, etc.). The inclusion of this chapter rendered the inclusion of a separate “Methods” section for the Thesis unnecessary.

3) Besides what is included in chapter 3 (article 1) additional details on background, statistical analyses, or other aspects pertaining to specific research goals are detailed on the Methods sections of articles 2, 3 and 4 (respectively, chapters 4, 5 and 6). Indeed, we thought it would more useful and appropriate to discuss different statistical techniques in different chapters, rather than to have a single Methods chapter. Thus, middle chapters are presented as individual empirical articles with their own abstract, introduction, methods, results, discussion and references sections.

4) Bibliographic references (at the end of each article) followed the format requested by the journal of submission/publication. The same also applied to other specific differences in format (e.g. legends, figures, and tables). For the general introduction and discussion sections the numbered format was adopted for references.

4) In the closing chapter (Chapter 7), findings from the middle empirical chapters are drawn together and discussed in light of literature and possible inferences to the long-term promotion of physical activity behaviors in the field of weight management. The potential utility of the

new findings for future intervention practices and foundations for theoretical developments are also discussed.

5) Finally, the Appendices section includes: i) questionnaires used in the Thesis; ii) abstracts of presentations (oral and poster) related to the studies presented in the Thesis, and; iii) two other articles (in Portuguese) published within the context of P.E.S.O study. One pertains to an ongoing community program originally based on the P.E.S.O. curriculum and experience – the PESO COMUNITÁRIO program.

Overview of Research Goals

A detailed explanation of the research goals that guided the development of the present Thesis is described below (organized by research articles):

Article I (chapter 3): The first of the four articles included in this Thesis is the study protocol, aimed at describing the P.E.S.O. II trial, which was conceived to test a novel obesity intervention program based on SDT. Furthermore, this article was also developed to present the rationale behind SDT's utility in facilitating and explaining health behavior change, especially physical activity/exercise, during obesity treatment. Study design, recruitment, inclusion criteria, measurements, and a detailed description of the intervention (general format, goals for the participants, intervention curriculum, and main strategies) were also addressed. The writing of this article is a recommendation from the Behavior Change Consortium, considering that intervention descriptions are often not specific about the techniques employed and that there is no clear correspondence between theoretical "inspiration" and adoption of particular behavior change techniques.

Article II (chapter 4) – Sequentially, the second article of this Thesis extended the description of the intervention into great detail and reported the impact of the intervention on

the study's main outcomes (body weight and composition, and physical activity) and analyzed the proposed theory-based mediators, comparing intermediate (4-month) and final (12-month) results for intervention vs. control groups. If an intervention is not properly implemented, it may not affect the proposed mediators and, as a consequence, outcomes may not be sufficiently improved. Hence, the theory-based variables were used as proximal outcomes indicator to determine whether the intervention actually changed the chosen mediators, as planned. This is important because even interventions which were reportedly based on certain behavior theories often do not measure and/or report changes in constructs that would (theoretically) predict behavior. Such measurements are critical for identifying the most salient constructs and for increasing their predictive potential, as well as for improving theory itself. Moreover, the most common outcome for measuring the impact of the obesity interventions is weight or BMI, with energy balance-related behaviors being more infrequently reported.

Article III (chapter 5) - Grounded in the theoretical background and in empirical propositions from literature (and from the previous articles), and fueled by the need to identify and test the processes or mechanisms by which theoretical predictors influence exercise behavior, this third study aimed to confirm the causal processes and mechanisms by which treatment promoted different forms of physical activity, during the one-year obesity treatment intervention. Thus, this study analyzed not only the mechanisms by which the intervention influenced physical activity level, but also whether motivational predictors differed for structured versus lifestyle forms of physical activity, searching for specific, differential mechanisms by which the intervention produced its effects. By using multiple-level mediation analyses for two different types of physical activity, evaluating by which causal mechanisms behavior might have been affected, this study represents an explicit attempt to test causal pathways proposed by the theory under scrutiny.

Article IV (Chapter 6) - In this fourth article, the goals and findings from the third article were extended to weight control in the long-term (two years after intervention's end), by exploring if the previously tested mechanisms were also predictive of exercise maintenance and long-term weight management. The primary purpose of this study was to evaluate predictors of successful long-term weight control, by analyzing the extent to which sustained exercise participation and theory-based exercise motivation variables mediated the impact of the intervention on 3-year weight change. This is a relevant research target considering the well-established need to identify predictors of sustained weight loss and lifestyle change over time.

Collectively, the four studies were designed to provide a comprehensive analysis of how a theory-based intervention, implemented to affect specific theory-based mediators, could impact exercise adherence and weight change, both in the short and long-term, from a SDT perspective. Considering whether interventions have successfully changed behavior, how effective they have been, how they have achieved their effects, and what particular psychological behavior change techniques have been identified are important research targets which the present Thesis aimed to address. Results are expected to contribute to a better understanding of how motivational characteristics, particularly those related to physical activity/exercise, influence treatment success during obesity treatment, while exploring the utility of SDT for promoting health behavior change in this most important context.

List of articles, books and conference presentations/abstracts

The investigation carried out as part of the present doctoral research program resulted in the following publications/submissions and presentations (oral and poster) with first authorship:

Books

Teixeira, P.J., Silva, M.N. (2009) *Repensar o PESO: Princípios e Métodos Testados para Controlar o Seu Peso*. Lisboa: Lidel – Edições Técnicas

Peer-reviewed articles published

Silva, M.N., Markland, D., Minderico, C.S., Vieira, P.N., Castro, M.M., Coutinho, S.R., Santos, T.C., Matos, M.G. & Teixeira P.J. (2008). A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: rationale and intervention description. *BMC Public Health*, 8: 234-247.

Silva, M. N., Vieira, P. N., Coutinho, S. R., Matos, M. G., Sardinha, L. B., & Teixeira, P. J. (2010). Using self-determination theory to promote physical activity and weight control: A randomized controlled trial in women. *Journal of Behavioural Medicine*, 33 (2): 110-122.

Silva, M.N., Markland D., Vieira P.N., Coutinho, S.R., Carraça, E.V., Palmeira, A.L., Minderico, C.S., Matos, M.G, Sardinha, L.B., Teixeira, P.J. (2010). Helping Overweight Women Become More Active: Need Support and Motivational Regulations for Different Forms of Physical Activity. *Psychology of Sport and Exercise*. doi:10.1016/j.psychsport.2010.06.011

Peer-reviewed articles in review

Silva, M.N., Markland, D., Carraça, E.V., Vieira, P.N., Coutinho, S.R., Minderico, C.S., Matos, M.G., Sardinha, L.B., Teixeira, P.J. Exercise Autonomous Motivation Predicts 3-Year Weight Loss in Women (*in review*).

Published Abstracts (oral and poster presentations)

Silva, MN, Vieira PN, Coutinho SR, Carraça EV, Santos, T, Markland D, Sardinha LB, Teixeira PJ. Autonomous motivation for exercise, exercise levels, and 3-year weight change: Results from a randomized controlled intervention. *International Journal of Obesity* (in press).

Silva M.N.; Markland, D; Vieira P.N., Coutinho S.R., Palmeira A.L., Carraça E.V., Sardinha L.B., Teixeira P.J.. Mediators of Different Types of Physical Activity During Behavioral Obesity Treatment. *Obesity*, 17 (supp 2):S273

Silva, M.N., Vieira, P.N., Coutinho, S.R., Palmeira, A.L., Carraça. E.V., Mata, J., Sardinha, L.B., Teixeira, P.J. (2009). Self-Determination and Exercise Intrinsic Motivation as Mediators of Physical Activity During a Weight Loss Program: One-Year Results from a Randomized Controlled Trial. *The European Journal of Obesity*, 2 (Supp 2):S29.

Silva, M.N., Vieira, P.N., Minderico, C.S., Castro, M.M., and Teixeira, P.J. (2008). Using self-determination theory and motivational interviewing for obesity treatment: 1-year results from a randomized controlled trial. *The European Journal of Obesity*, 32 (sup. 1): S144.

Silva, M.N., Vieira, P.N., Minderico, C.S., Castro, M.M., and Teixeira, P.J. (2007). Using self-determination theory and motivational interviewing for obesity treatment: 1-year

results from a randomized controlled trial. *The European Journal of Obesity* 31(supp. 1): S144.

Other Publications (*International*)

Silva, M.N., Vieira, P.N., Carraça, E.V., Palmeira, A., Coutinho, S.R., Santos, T., Sardinha, L.B. e Teixeira, P.J. (2009). Promoting autonomy and intrinsic motivation for physical activity in overweight and obese women. The 8th Annual Conference of the International Society for Behavioral Nutrition and Physical Activity, *ISBNPA*. FMH Edições Lisbon, Portugal.

Silva M.N., Teixeira P.J., Vieira P.N., Castro, M.M., Minderico C.S., Coutinho C.S., Santos, T.C., Palmeira A.L., Markland D, Sardinha L.B. (2008) Exercise Intrinsic Motivation, Autonomous Self-Regulation, and Psychological Motives as Mediators of Physical Activity During Weight Management. International Society for Behavioral Nutrition and Physical Activity. *ISBNPA*. Banff, Canada.

Silva, MN., Vieira, P.N., Minderico, C.S., Castro, M.M, Coutinho, S., Santos, T.C., Teixeira, P.J. (2007). Testing a Portuguese Self-Determination Theory-based Psychometric battery. International Society for Behavioral Nutrition and Physical Activity. *ISBNPA*. Oslo, Noruega.

Silva, M.N., Vieira, P.N., Minderico, C.S., Castro, M.M., and Teixeira, P.J. (2007). A Randomized Controlled Trial of Behavioral Weight Control Based on Self-Determination Theory: Change in Putative Mediators and Body Weight. Third International Self-Determination Theory Conference. Toronto, Canada

Silva, MN., Vieira, P., Minderico, C., Castro, M., Teixeira (2006) “Change in body weight and psychosocial mediators from self determination theory during behavioural obesity

treatment” International Society for Behavioral Nutrition and Physical Activity. *ISBNPA*. Boston, EUA

Silva, MN., Vieira, P., Minderico, C., Castro, M., Teixeira (2005) “A Randomized Controlled Trial of Behavioral Weight Control Based on Self-Determination Theory in Women”. International Society for Behavioral Nutrition and Physical Activity. *ISBNPA* Amsterdam, Netherlands

National

Articles

Silva, M.N., Santos, T.C., Coutinho, S.R., Marcelino, M.S., Vieira, P.N., Tomás, R.A., Carraça, E.V., Minderico, C.S., Sardinha, L.B. e Teixeira, P.J. (2009). O Programa PESO COMUNITÁRIO. *Comportamento Alimentar*. 6 (12): 1-12.

Silva. M.N., Teixeira, P.J., Vieira, P.N., Minderico, C.S., Castro, M.M., Coutinho, S., Carraça, E. Marcelino, M., Santos, T., Sardinha L.B. (2007). Programa P.E.S.O. - Promoção do Exercício e Saúde na Obesidade: Metodologia e Descrição da Intervenção. *ENDO-Endocrinologia, Diabetes e Obesidade*, 1:5-10.

Presentations

Silva, MN. O Controlo do Peso: Que Regulação Comportamental Promover? In Seminário Exercício e Bem-Estar, Câmara Municipal de Portimão. Portimão, Maio 2010.

Silva, MN. Actividade(s) física(s): Diferentes formas de promoção e suas implicações para a gestão do peso no longo prazo. In Simpósio 4 “Diga-me o que fazer...!”: a regulação

externa e a motivação para a alimentação e exercício físico. 13º Congresso Português da Sociedade Portuguesa para o Estudo da Obesidade. Vilamoura, Novembro de 2009.

Silva, MN. O Papel da Regulação Emocional no Controlo Alimentar. In simpósio: apetite e sua (des) regulação. 8º Congresso da Sociedade Portuguesa de Ciências da Nutrição e Alimentação. Porto, Outubro de 2009.

Silva, MN. Prevenção e tratamento da obesidade no concelho de Oeiras: o Programa P.E.S.O. In SEMINÁRIO INTERNACIONAL: Comunidades (+) Saudáveis e Promoção de Estilos de Vida Activos. Oeiras, Maio de 2009.

Silva, MN. Mudança comportamental em adultos em grupo. In Simpósio 6: Modificação Comportamental para a Actividade Física. 12º Congresso da Sociedade Portuguesa para o Estudo da Obesidade. Aveiro, Novembro de 2008.

Silva, MN. O papel do psicólogo. In Simpósio: Que conhecimentos e competências em Actividade Física necessitam os diferentes Profissionais de Saúde? 1ªs Jornadas de Exercício e Saúde em Medicina da Universidade da Beira Interior. Covilhã, Outubro de 2008.

Silva, MN. Determinantes Psicossociais do Comportamento Alimentar: Implicações para a Prática. In Simpósio: Influências dos Aspectos Psicológicos ao Nível da Nutrição. *Instituto Superior de Ciências da Saúde Egas Moniz*. Caparica, Maio de 2008.

Silva, MN. O Programa PESO COMUNITÁRIO. In Prevenção da Obesidade: *Fórum de projectos*. Direcção Geral da Saúde. Lisboa, Junho de 2008.

Silva, M.N., Vieira P.N., Minderico C.S., Castro M.C., Coutinho S.R., Santos T.C., Teixeira P.J. (2008) Promoção da Actividade Física e Controlo do Peso em Mulheres com Excesso Ponderal: Impacto de Uma Intervenção Baseada na Teoria da Auto-Determinação.

Encontro Nacional da Sociedade Portuguesa de Psicologia da Saúde – Intervenção em Psicologia e Saúde - Porto, 2008.

Silva, M.N., Vieira, P., Minderico, C., Castro, M., Teixeira, P., "Emagrecer com Saúde na Faculdade: O Programa Peso", Exercício, Desporto e Saúde: Sinergias da Psicologia e da Medicina, Universidade Lusófona. Lisboa, Maio de 2006

Silva, M.N., Vieira, P., Minderico, C., Castro, M., Teixeira "Impacto de uma Intervenção Baseada na Teoria da Auto-Determinação para a Promoção da Actividade Física e Controlo do Peso" 6º Congresso Sociedade Portuguesa de Psicologia da Saúde, Fevereiro de 2006

Silva, MN., Vieira, P., Teixeira. "Validação preliminar para português de uma Bateria de Instrumentos de Avaliação da Teoria da Auto Determinação".Jornadas de Saúde e Comportamento, Universidade do Minho, Junho de 2005

CHAPTER 2

General Introduction

“Evaluations of behavior change interventions need to answer three questions about an intervention. First, *does it work?* Second, *how well does it work?* Third, *how does it work?*”

Michie & Abraham, 2004, p.29

Overweight and Obesity

The definition of obesity

According to a panel of experts from the Obesity Society in North America, obesity is simply defined as an excess of body fat. It may be of either total body fat or a particular depot of body fat [1]. The excess may even be in the morphology and function of body fat such that, for example, adipocytes, independent of total fat mass or fat mass distribution, are excessively enlarged. The adverse health consequences of accumulation of enlarged visceral or other adipocytes may tentatively be accounted for by enhanced secretion of most products of adipocytes that act as endocrine and paracrine factors on other cells, as well as the reduced production of adiponectin [2].

In clinical practice, body fat is most commonly and simply estimated by using a formula that combines weight and height. The underlying assumption is that most variation in weight for persons of the same height is due to fat mass, and the formula most frequently used in epidemiological studies is the body-mass index (BMI), which refers to the weight in kilograms divided by the square of the height in meters [3]. This graded classification provides valuable information about increasing body fatness: <18.5-Underweight, 18.5–24.9 regular weight, 25.0–29.9 Pre-obese state, 30.0–34.9 obesity grade I, 35.0–39.9 obesity grade II, ≥ 40.0 obesity grade III. It allows meaningful comparisons of weight status within and between populations and the identification of individuals and groups at risk of morbidity and mortality. It also permits identification of priorities for intervention at an individual or community level and for evaluating the effectiveness of such interventions. However this method has some limitations. Indeed, despite the mentioned clinical and practical advantages it is important to consider that due to differences in body proportions, BMI may not correspond to the same degree of fatness across different populations. Nor does it account for

the wide variation in the nature of obesity between different individuals and populations [4]. To obviate these problems, several other methods (that evaluate excess of body fat) have been considered and discussed (waist circumference, skinfold thickness, bioimpedance). However, they will not be detailed here.

Despite the mentioned limitations, there is a close relationship between BMI and the incidence of several chronic conditions caused by excess fat, including type 2 diabetes, hypertension, and cholelithiasis. This relationship is approximately linear for a range of BMI indexes less than 30 (kg m^{-2}), but all risks are greatly increased for those subjects with a BMI above 29, independent of gender [5, 6].

Obesity's causes: A mismatch between physiology and modern environment

There has been considerable debate concerning the contribution of genetic vs. non-genetic factors to the obesity prevalence. Obesity is not a single disorder but a heterogeneous group of conditions with multiple causes. There is relative agreement that it results from an interaction between environmental (cultural, economic, social) and individual factors (e.g. genetic, psychological) acting through the physiological mediators of energy intake and expenditure. Thus, the marked rise in the prevalence of obesity might best be attributed to a mismatch between our physiology and our modern environment [7]. In previous times, when a high level of physical activity was required for daily subsistence and the food supply was inconsistent, control of body weight was largely accomplished through innate physiological processes and required little conscious effort. Physical activity was the primary driving force, and the challenge to the body weight control system was to provide a strong drive to eat to keep pace with energy expenditure. Basically, the biology developed to encourage adaptive behaviors, such that people ate when food was available and 'rested' when physical activity

was not required. Because of the importance of ensuring sufficient energy intake for survival and reproduction, multiple redundant physiological systems evolved to encourage eating behavior. To complement this capacity, because food shortages were a frequent occurrence throughout human history [8], our physiology also developed the capacity to reduce metabolic rate in response to negative energy balance. Finally, to ensure survival, the system probably evolved with an additional bias toward ‘conserving energy’ when physical activity was not required. There is no published evidence of a physiological drive to engage in physical activity for its own sake [7]. Thus, according to Aslam [9], obesity is changing, but its origins can be traced back 30 000 years, to our prehistoric ancestors. Survival of the fittest dictated that individuals who stored energy in the most efficient way would survive the inevitable fast and famine that would follow times of plenty. This has been attributed to the ‘thrifty gene’ (although no such individual gene exists), ensuring the continued dominance of our hunter-gatherer predecessors [9]. But natural selection has turned on us. Life now favors inefficient phenotypes that fail to store energy in adipose depots, while those that lay down fat in the abdomen are condemned to premature death. To fight obesity, we are flying in the face of evolution and instinct, consciously countermanding the urge to eat for survival, and be as inactive as possible in order to conserve energy. Similarly, for Peters et al [7], the rising obesity prevalence rates, now over 60% in the United States [10], suggest that the environment has changed in such a way that fewer and fewer people are able to maintain a healthy body weight by relying on their own biology and ‘instinctual’ mechanisms to protect them. The biological processes that developed with a bias toward ensuring survival still seem to work well, i.e. people still eat when food is available and ‘rest’ when physical activity is not required. The problem is that food is nearly always available and physical activity is seldom required. In this way, the current environment in the United States and in much of the developed world exerts consistent, unidirectional influences on energy intake and energy

expenditure that promote sustained positive energy balance and weight gain. In fact, there appears to be little evidence of regulatory signals that protect humans from slow, continuous weight gain under modern western conditions. Indeed, weight gaining may even be a pattern throughout lifespan. According to Kuczmarski et al [11], in both men and women the prevalence of overweight and obesity increases with age until 50 to 60 years; it is particularly apparent between the ages of 20 and 40 years. There are large, usually unexplained variations, between ethnic groups — this is particularly apparent in US women with the rapidity of change occurring with increasing affluence of particular lower economic groups (22% of Caucasian women, 30% of African-American women, and 34% of Mexican-American women are obese). In industrialized countries, a higher prevalence of overweight and obesity is observed in those with lower educational attainments and low income, although the reverse may be seen in developing countries. Furthermore, there is a tendency for overweight to increase after marriage and with increasing parity.

Epidemiology of overweight and obesity in Europe and Portugal

The prevalence of obesity in Europe is in the range of 10–25% in men and 10–30% in women [12]. In the past 10 years the prevalence of obesity has increased by 10–40% in the majority of European countries. In most countries more than 50% of people are overweight or obese [13]. The prevalence of obesity was higher among men than among women in 14 of 36 countries or regions with data for both genders, and the prevalence of overweight was higher among men in all 36 countries [13].

Portugal is not an exception regarding this health problem, as in other Southern European nations, social issues such as urbanization, modernization of working practices and improvement of social conditions, were followed by sedentary lifestyles and bad nutritional

habits. The most recent (2003–2005) Portuguese nationwide representative study on obesity, with objective anthropometric measurements, (participants aged 18–64), evidenced that 39.4% of the sample were overweight (BMI between 25.0 and 29.9), and 14.2% were obese (BMI >30) [14]. Considering only obesity categories, it was observed that obesity grade II (35.0-39.9) and grade III (>40) represented a small minority (2.0 % and 0.6 % respectively) [15]. Waist circumference measurement results showed that 45.6% of the sample suffers increased cardiovascular health risks associated with high waist circumference. Middle age is the period of life where the highest prevalence of overweight/obesity can be found. These data also revealed that the overweight/obesity prevalence increased from 49.6% to 53.6% over the last decade (men and women together). This increase seems to result mainly from a shift from normal (47.8% in 1995–1998 and 44.2% in 2003–2005; $P<0.0001$) to overweight categories (35.2% in 1995–1998 and 39.4% in 2003–2005; $P<0.0001$). The prevalence of overweight/obesity among men is higher (60.2%) than among women (47.8%) [14]. This difference between genders is consistent with the previous study from 1995 to 1998 [16].

Physical and psychological consequences of obesity

The World Health Organization (WHO) concluded that obesity is the major unmet public health problem worldwide [13]. According to the mentioned organization, this condition is now so common within the world's population that it is starting to replace undernutrition and infectious diseases as the most significant contributor to ill health. The negative health consequences of obesity are well documented [17, 18], and clear and consistent evidence shows that this endemic health problem increases the risk of several morbidities and reduces both in length and quality of life. In particular, obesity is associated with diabetes mellitus,

coronary heart disease, certain forms of cancer, respiratory complications (obstructive sleep apnea) and osteoarthritis of large and small joints [3, 19]. Kopelman [4] defended that generalized obesity results in alterations in total blood volume and cardiac function, whereas the distribution of fat around the thoracic cage and abdomen restricts respiratory excursion and alters respiratory function. The intra-abdominal visceral deposition of adipose tissue, which characterizes upper body obesity, is a major contributor to the development of hypertension, elevated plasma insulin concentrations and insulin resistance, diabetes mellitus and hyperlipidaemia.

Recently, a panel of experts from the leading professional obesity society in North America, TOS [1], recognized that obesity causes much suffering, obesity causally leads to many aspects of ill health, to functional impairment and reduced quality of life, to serious disease, and to greater mortality, obese persons are subject to severe societal discrimination in ways that those with seemingly similar chronic conditions, such as hypertension, dyslipidemia, and diabetes, are not. For example, obese individuals are waited on more slowly by salespersons, less likely to be rented apartments, less likely to be offered jobs, even when as qualified as other applicants, and less likely to receive support for higher education from parents, and often are looked down on by educators and health professionals. Indeed, the current understanding of obesity by the population at large consists mainly of two positions. One position equates obesity with poor character, lack of self-control, laziness, and gluttony. It views obesity as the result of an individual's choice of behavior, like smoking or driving without a seatbelt, that has relatively little effect on others—a lifestyle choice. The other position sees obesity as a risk factor or a stage on the path to a real disease such as heart disease or diabetes. In this view, a reduction in obesity is seen as useful in reducing the risk of other diseases. However, reduction in body weight for its own sake is often associated with vanity or seen as a cosmetic issue. A third viewpoint is that obesity is a genetically determined

trait (evidence clearly indicates that both genetic and environmental factors contribute to obesity), not very different from hair or eye color, and not a disease. Each one of these points of view has its own perils for the field of obesity prevention and treatment. If the last one can contribute to a feeling of helplessness and attitudes such as “I am like this and there is nothing I can do”, the first one is cause of deleterious social pressure.

Indeed, there is a cultural notion proposing that some degree of body dissatisfaction may motivate weight control behaviors. If experiencing weight stigma leads to increased body dissatisfaction, which, in turn, leads to increased weight loss efforts, one could argue that stigma might serve as a motivator to lose weight. This view is reinforced by examples in the popular media of individuals losing weight after a humiliating experience of weight-based stigmatization. Several studies have established that overweight and obese people are subjected to negative stereotypes and discrimination in various areas, including employment, education and the health care system [20]. With this regard, Cash [21] alerted for the deleterious effects of the physical objectification of females in Western societies, which are well established, particularly in relation to the prominent and progressively thin ideal standard of beauty promulgated by the media. Many females come to internalize these cultural expectations and judge their physical and personal self-worth in relation to unrealistic and extreme standards [22]. Thus, among the overweight and obese segments of the population, as the pressure for thinness increases, the discrepancy between desirable body weight and actual body weight increases as well. This should serve to intensify the body-image concerns of those who are objectively overweight [23]. However, according to Puhl et al [24], there is no evidence to suggest that the social pressures and weight bias serves the mentioned motivational function. In fact, if this were the case, one would expect the increase in weight bias over the past 40 years to be associated with a decrease in the rates of obesity, rather than the recent significant increase. Recent findings suggest that obese individuals who internalize

negative weight-based stereotypes may be particularly vulnerable to the negative impact of stigma on eating behaviors and also challenge the notion that stigma may motivate obese individuals to engage in efforts to lose weight [24].

This area of research may also shed some light into the subject of obesity and psychological health. In fact, according to Friedman et al. [23] the nature of the relationship between obesity and psychological distress continues to be debated by researchers and clinicians alike. Studies of non-clinical samples of obese persons have consistently shown that obese individuals do not differ from their non-obese counterparts in psychological symptoms, psychopathology, or personality overall [25]. However, body-image factors consistently discriminate obese from their non-obese counterparts [24]. It has been reported that overweight individuals, particularly women, are more negative about their level of fitness and overall health status than their normal weight counterparts [26]. Moreover, according to Sarwer et al. [27], negative body image in treatment-seeking obese individuals is related to general psychological well-being, such that high levels of body dissatisfaction are associated with elevated depression and decreased levels of self-esteem, (It should be noted that for non-obese women there seems to be a similar, albeit weaker, relationship between body-image dissatisfaction and depression and self-esteem). Because those who seek treatment for their weight are at least partially motivated by negative evaluations of their body, the relationship between body image and psychological distress is likely to be even more prominent in the most obese of these treatment seekers. This would suggest that in treatment-seeking populations, the degree of obesity is related to the level of psychological distress.

The option for a sample of pre-menopausal overweight women for the Promotion of Exercise and Health in Obesity study (PESO) (within which this Thesis was conducted- see study one,

chapter 4) had to do with the already stated higher risk for social pressure and stigma in women, leading to poor psychological profiles (many times contributing to vicious circles of more weight-gaining [22]),, particularly, as it was mentioned before, in middle-age persons (a time frame very risky for gaining weight).

Treatment and long-term outcomes

The above mentioned facts lead to the conclusion that the time for concerted action to reduce levels of obesity and the deleterious effects of obesity is clearly upon us. However the costs of treating this disease are of such magnitude as to potentially overwhelm the health-care systems of many countries [13]. Even for proponents of the identification of major and minor genes involved in the etiology and pathogenesis of obesity as the critically important challenge for the immediate future [e.g. 4], the development and implementation of effective programs that successfully encourage increased physical activity and healthy eating across populations remain paramount for the prevention of obesity and its associated diseases.

For Haslam [9] the history of obesity management is a history of failure. Whereas cancer treatment requires new drugs and heart disease updated techniques, obesity is different. Looking back in time gives many insights and proves as to what can constitute treatment. Indeed, thousands of years ahead of his time, Hippocrates correctly identified the energy balance equation: “It is very injurious to health to take in more food than the constitution will bear, when, at the same time one uses no exercise to carry off this excess” [28].

Nowadays the Diabetes Prevention Program (DPP) provided definitive evidence of the health benefits of lifestyle intervention for weight control [29, 30]. This 4-year study examined 3200 overweight or obese individuals with impaired glucose tolerance and found that a lifestyle intervention designed to induce a 7% reduction in initial weight and increase physical activity

to 150 min/wk reduced the risk of developing type 2 diabetes by 58% compared with placebo. The intervention was also more effective than metformin, a medication for type 2 diabetes. A Finnish study yielded the same results: individuals who lost 4.3 kg with diet and exercise reduced their risk of developing type 2 diabetes by 58% compared with a control group [31]. These two studies, together with a more recent trial, the Look Ahead study (i.e., Action for Health in Diabetes) [32], where participants in the lifestyle intervention received a 4-year behavioral program, leave little doubt of the efficacy of lifestyle modification in facilitating improvements in weight and health.

All of mentioned programs made use, as mentioned, of lifestyle modification. With this regard, according to Wadden and Butryn [33] the terms “lifestyle modification”, “behavioral treatment”, and “behavioral weight control” are often used interchangeably. They all encompass three principal components: diet, exercise, and behavior therapy. The last term refers to a set of principles and techniques for modifying diet and exercise. However, while behavioral approaches to the management of obesity are often successful in achieving initial clinically significant weight loss, when the weight reduction programs end the weight lost is generally regained [34]. Indeed, according to a review by Wadden and Butryn [33], the weight regain is a problem after virtually all dietary and behavioral interventions for obesity. Overall, patients treated by group lifestyle modification regain 30% to 35% of their lost weight in the year after treatment. Weight regain slows after the first year, but by 5 years, 50% or more of patients are likely to have returned to their baseline weight. Wing and Phelan [35], based on results of random digit dial surveys, suggested that only about 20% of overweight individuals are successful at long-term weight loss when defined as losing at least 10% of initial body weight and maintaining the loss for at least 1 year. For example, in the DPP, lifestyle-treated participants lost 7 kg at the end of the first year and then regained 1 kg per year in the ensuing 3 years [32]. Unhealthy eating and exercise habits resurface within weeks to months of

completing treatment and empirical evidence highlights the small average long-term weight change (3-4% on initial weight) [36].

A key question we need to address is what makes maintenance so difficult: is it physiology or psychology or both? Better understanding of the problems inherent in long-term maintenance of weight loss may allow development of more effective weight loss maintenance strategies [37]. Remarkably, little is known about factors responsible for weight regain, despite the frequency with which this problem is observed. Contributors are likely to include compensatory metabolic responses to weight loss that include reductions in resting energy expenditure [38] and leptin [39] and increases in ghrelin (a gut peptide associated with reports of hunger)[40]. These physiological responses to both energy restriction and weight loss protect humans against the adverse effects of starvation [41]. In addition, once patients leave treatment, they are confronted daily by an environment that explicitly encourages them to consume large quantities of foods, high in fat and sugar [42]. The mentioned studies that have followed-up obese patients who have participated in treatment trials have suggested that relapse is attributable to individuals' failure to persist with the weight-control behaviors that they adopted to achieve weight loss, such as the consumption of a low-fat diet; regular physical activity; and the regular monitoring of body weight. However, little attention has been paid to why this is the case and how some formerly obese individuals are able to persist with these forms of behavior. Indeed, it should be acknowledged that a large individual variability exists in results from weight loss trials. Thus, focusing on the identification of factors associated with success will enhance the understanding of the most critical mechanisms involved, and should be a research priority [43, 44].

Physical activity and long-term weight control

Physical activity encompasses all movement produced by skeletal muscles that confers energy expenditure above rest [45]. A number of categories of physical activity subsume this overarching definition, such as activity performed in occupational, household, transport and leisure-time contexts. Probably most appropriately (although not exclusively) nested within leisure-time physical activity, Caspersen et al. [45] define exercise as a sub-component of physical activity that is more “planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective” (p.128). Thus people can increase their energy expenditure in two ways—programmed/structured or lifestyle activity. Programmed/structured activity (e.g., walking, biking, swimming) is typically planned and completed in a discrete period of time (i.e., 30 to 60 minutes) at a relatively high-intensity level (i.e., 60% to 80% of maximum heart rate). Lifestyle activity, by contrast, involves increasing energy expenditure while completing everyday tasks. Patients may, for example, increase their lifestyle activity by parking further away from building entrances, taking stairs rather than escalators, or even by discarding the remote control to the television [33]. Andersen and colleagues [46], in a study with obese women, found that both types of activity, when combined with a 1200 kcal/d diet, induced a loss of 8 kg in 16 weeks. Despite methodological limitations in evaluating the true effects of lifestyle physical activity on weight control and remaining questions as to the best lifestyle physical activity prescription, the latest Position Statement from the American College of Sports Medicine [47], concluded that lifestyle physical activity is useful for weight management and also to counter the small energy imbalance responsible for obesity in most adults.

Physical activity is recommended as an important part of weight management by virtually all public health agencies and scientific organizations including the World Health Organization [13], the National Institutes of Health [3, 48], the American College of Sports Medicine [47], and various medical societies (e.g. American Heart Association, American Medical Association, American Academy of Family Physicians) [see 49]. Data from retrospective studies [50, 51], correlational investigations [52], and randomized trials [53-56] all have concluded that high levels of physical activity facilitate long-term weight control. However, systematic reviews [e.g. 48, 57] noticed that non-randomized designs have more consistently showed this relation, especially at the highest adherence categories, concluding that research results are highly dependent on study design, intervention adherence and analytic design. The most consistent finding was that a large volume of physical activity was associated with less weight gain, a fact that has been especially highlighted in studies from the US National Weight Control Registry [58]. Indeed, this Registry has provided continuous insight into the process of weight maintenance [37]. In over 3500 successful weight loss maintainers, several common themes have emerged, with the expenditure of large amounts of energy in voluntary physical activity as the most consistent [58]. Congruently with these findings, Jeffery and colleagues [54] compared the benefits of low versus high levels of physical activity in a randomized controlled trial. Participants in the high-activity group were instructed to expend 2500 kcal/wk, whereas those in the low group were prescribed a goal of 1000 kcal/wk. At the end of 6 months, during which participants attended weekly group meetings, weight loss in the two groups did not differ significantly. However, participants in the high activity group maintained their weight loss significantly better than did patients in the low-activity group at both the 12- and 18-month assessments. Jakicic and colleagues [59] similarly found, in secondary analyses of results of a randomized trial, that obese individuals who exercised 200

or more min/wk achieved significantly greater weight loss at 18 months than did individuals who exercised fewer than 150 min/wk.

A recent study prospectively examined the associations between patterns of discretionary physical activity and 6-year maintenance of intentional weight loss among 4,558 healthy premenopausal women (from the Nurses' Health Study II) [60], and founded that, compared to women who remained sedentary, women were less likely to regain >30% of the lost weight if they maintained 30+ min/day of discretionary PA (odds ratio (OR) = 0.69, 0.53 to 0.89) or increased to this activity level (OR = 0.48, 0.39 to 0.60). Conversely, risk was elevated in women who decreased their activity. Thus, it was concluded that increased PA, particularly high intensity activities, is associated with better maintenance of weight loss [60]. In the summary statement of the already mentioned latest Position Statement from the American College of Sports Medicine on physical activity strategies for weight management [47], it is indicated that physical activity will promote clinically significant weight loss, specifically at higher doses, i.e., above 225 min/wk of moderately vigorous physical activity (associated with a loss of 5-7.5 kg). Doses in the range of 150-200 min/wk are associated with ~2-3 kg losses [47].

According to Fogelholm & Kukkonen-Harjula [57] the evidence that a larger volume of physical activity is associated with less weight gain, could be interpreted in three different ways, stating that: "First, physical activity may really prevent weight gain; second, less weight gain may lead to better exercise adherence; third, engagement in physical activity may be a proxy for a generally healthier lifestyle or psychological profile (e.g. better self-regulation). The fact that the more rigorous study designs (randomized trials) yielded very inconsistent results leads us to conjecture that the association between physical activity and weight change is more complex than judged from retrospective, cross-sectional studies" (p.106).

Mechanisms of action

The most critical pathways by which exercise contributes to safe and effective obesity treatment are still under investigation [61-63]. The most important physiological mechanism is that increased physical activity helps to keep patients in energy balance. In addition, exercise spares the loss of fat-free mass during diet-induced weight loss [64], an occurrence that could help minimize undesired reductions in resting-energy expenditure [61]. Indeed, both fat and lean tissue are lost during weight loss, but the ratio of fat to lean tissue is, *inter alia*, dependent on rate of weight lost and initial body composition, and on the dose of physical activity [65, 66]. Furthermore, it has variously been suggested that physical activity increases fat oxidation [e.g. 67].

Increasingly, researchers are also highlighting the role of psychological mechanisms associated with regular exercise participation, specifically in the overweight and obese population (e.g., improved well-being and self-esteem, reduced anxiety and depression, and also enhanced self-regulatory skills) [63]. These could also affect long-term weight control, for example by their effect on compliance with dietary changes [68, 69]. For instance, a recent study indicated the possibility of “spill-over” effects in self-regulation, showing that increased general self-determination and exercise motivation facilitated improvements in eating self-regulation during weight control in women [70]. Certain types of regulations/motivational styles may also be more associated than others with psychological well-being, for instance at the emotional and self-perception levels [71]. These aspects are often ignored in the behavior change literature, specifically in obesity studies, but there are suggestions that, for example, improved self-worth and body image are associated with more internal exercise motivation [72] and can also benefit weight control [73]. There may, in fact, be an intricate interplay between physiology and psychology regarding the effects of exercise on sustained weight loss. However, this interplay only applies if the exercise is actually performed [e.g. 57]. Thus,

regardless of the mechanism of action, the message is the same: People should increase their physical activity by whatever means possible.

The problem of long-term adherence

Despite agreement as to the adequate dose of exercise and physical activity, poor behavioral adherence partially explains sub-optimal results in exercise-based interventions [74]. Indeed, evidence suggests that more than 70% of US adults fail to meet current physical activity recommendations [75]. In Europe, the Eurobarometer [76, 77] indicates that although the amount of physical activity is low, a wide disparity exists (e.g. Northern European countries showing higher levels of physical activity than southern countries) with Portugal reporting the highest percentage (87.8%) of sedentary lifestyles [78] and the lowest prevalence (40.7%) of any physical activity during leisure time [79]. Recent data from the Portuguese Physical Activity Surveillance System (Observatório Nacional da Actividade Física) [80], assessed with objective methods (accelerometers), indicated that, at least in what concerns to health improvement, more than a half of the adult population is sufficiently active: 63,7% (women) and 76,7 (men) performed 30 minutes/day of moderate physical activity (in bouts of at least 10 minutes). However, following the ACSM position stand recommendations [47], the actual physical activity performed may be insufficient, in the case of the overweight population, for long-term weight-loss, and more specifically weight-regain prevention after weight-loss. These numbers raise the central, but largely unanswered, question of how to optimally facilitate the adoption of a physically active lifestyle among those overweight and obese, and particularly how to assist them in *maintaining* physical activity levels over the long-term.

The National Weight Control Registry [35], by studying the characteristics of successful maintainers, highlighted six key strategies for long term success at weight loss, with energy

expenditure at the top of the list: 1) engaging in high levels of physical activity; 2) eating a diet that is low in calories and fat; 3) eating breakfast; 4) self-monitoring weight on a regular basis; 5) maintaining a consistent eating pattern; and 6) catching “slips” before they turn into larger regains. However additional studies are needed to determine the factors responsible for registry participants’ apparent ability to adhere to these strategies for a long period of time in the context of a “toxic” environment that strongly encourages passive overeating and sedentary lifestyles. Indeed, to date, little attention has been given to the predictors of behavioral maintenance, and even when maintenance is explicitly identified, the promoting mechanisms have not been identified [36, 55].

To improve our understanding of behavioral maintenance, studies that monitor people through at least 2 years of follow-up, such as the Project Active trials [81], are needed in overweight and obese people. Furthermore it should be acknowledged that a large individual variability exists in results from weight loss trials. Thus, focusing on the identification of factors associated with success will enhance the understanding of the most critical mechanisms involved [43, 82]. Thus, research on theory-based treatment-induced mediators of behavior change is critical to identify potential causal mechanisms through which interventions operate; randomized controlled trials provide the ideal setting for such work [83].

The need for new research approaches

There is an increasing recognition that obesity is strikingly heterogeneous with respect to etiology, effects of excess weight, and response to various treatments [3, 33, 37], this led to the plausible hypothesis that also the psychological correlates of obesity (and its associated behaviors) vary across individuals and may play a role in the reported variation.

To address this individual heterogeneity involving obesity (particularly regarding the psychological variables involved) Friedman and Brownell [84] proposed a generational approach. According to these researchers the first generation of studies, comparing obese and non-obese persons have generally failed to find differences in global aspects of psychological functioning. For Friedman and Brownell the consequent often-cited notion that obesity has no psychological consequences may be a byproduct of the manner in which the first generation of studies in the field has been conducted. Thus, in order to move the field forward the mentioned researchers proposed a second generation of studies focusing on risk factor models to identify the individuals who will suffer from their obesity and the areas of functioning most affected. Recommendations extend to a third generation of studies that will establish causal pathways and mechanisms, needing longitudinal work and research designs configuring randomized controlled trials.

Recent expert opinions (e.g. Teixeira, 2009, personal communication) advocated that this generational approach can also be translated to the evolution of behavior change' research paradigms in the field of obesity. This way the first generation of study was concerned with the search for main effects (e.g. "which interventions are better?"; "how much weight loss or maintenance?"), the second generation was focused on testing interaction effects-moderators (e.g. "Who will lose weight"; "What are the best intervention for whom?"), and the third generation are currently looking for causal mechanisms of (behavioral) change ("How does it occur?").

Research background: mechanisms of intervention' success

The importance of randomized clinical trials

Randomized controlled trials (RCTs) have been the “gold standard” of evaluating the efficacy or effectiveness of clinical interventions. Randomized clinical trials are based on well recognized principles that underlie guidelines, such as the CONSORT (Consolidated Standards of Reporting Trials [85]). According to Kraemer et al. [86] the characteristics of a well performed RCT are established and include the following features: 1) A Well-defined and justified population, with a representative sample of sufficient size to yield power to detect clinically significant differences and to provide accurate estimates of effect sizes; 2) One or more control or comparison groups, it is a basic tenet of RCT methods that one cannot estimate the treatment effect except in relation to another control group. This is because when one evaluates one treatment alone, even the most inert placebo, one may see that appears to be change in response due to artifacts, such as statistical regression to the mean. For example, in the case of treatment trials, participants may emphasize their problems at the beginning of treatment and seek to acknowledge their appreciation at the end, thereby exaggerating apparent intervention effectiveness. 3) Randomization to treatment and control or comparison groups to avoid confusing selection affects with treatment effects; 4) A few a priori well chosen and justified outcome measures, selected in advance of the trial. 5) Analysis performed by intention to treat, i.e., all randomized subjects are included in the analysis of outcome; 6) A valid test for statistical significance and estimates of effect sizes informative enough to guide consideration of clinical and political significance. With this regard, congruently, Oakley et al. [87] pointed out four main indicators of methodological rigor, namely, 1) Employing a randomly allocated or matched control group, 2) Reporting pre-intervention and post-intervention data, 3) Reporting “intention-to-treat” analyses or controlling for differential

attrition, and 4) reporting on all outcomes indicated by the aims of the intervention. Furthermore, it was also noted that providing an intervention description that allows replication and ensuring adequate statistical power are crucial.

Acknowledging the importance for an RCT to cover and report the identified features, Chapters 3 and 4 presented in detail the study design and procedures and the main outcomes of the P.E.S.O Trial (Promotion of Exercise and health in Obesity), the chosen research design, within which all the analyses of the present Thesis were conducted and discussed. These two chapters aimed also to answer Michie & Abraham's [88] two first main questions regarding the evaluation of behavior change interventions, does it work? and How well does it work?, by demonstrating if the targeted intervention has produced measurable improvement relative to an appropriate control group and estimating effect sizes to assess intervention success, allowing comparison of the effectiveness with different interventions and enable researchers to estimate how much difference the intervention is likely to make if applied in practice.

According to Kraemer et al. [86], several well performed RCTs often fail to provide information most crucial to evaluating the treatment under study and thus to improving clinical decision making. Bauman et al. [89] further argued that for research on behavior change interventions to progress systematically, the mechanisms of action must be studied, acknowledging the importance of understanding intervention processes. This researcher recognizes, however, that if the process of identifying mechanisms of action is a common part of biological research, it is less common in health behavior research. If behavioral change *per se* is often the aim or “central outcome” of health care, as Kaplan [90] argued, the key

questions with this regard must not only pertain to *which behavior change interventions work?* But mostly by *which mechanisms?* In line with these premises, Michie & Abraham [88] added to the already mentioned two main questions a third one: *How interventions work?* Thus, rapid progress in identifying the most effective treatments and understanding why treatments work or do not work depends on efforts to identify mediators of treatment outcome, a research endeavor that lead all the mentioned researchers to recommend that RCT routinely include and report such analyses.

Mediators of treatment effects: intervening causal variables

Baron and Kenny [91] describe a mediator variable as “the generative mechanism through which the focal independent variable is able to influence the dependent variable of interest (pp. 1173, 1178)”. More recently, Mckinnon et al. [92] defined mediators as variables that transmit the effect of an independent variable on a dependent variable, similarly to Bauman [89], who conceptualized mediators as intervening causal variables that are on the causal pathway between exposure to the intervention and program effects or outcomes, assuming that there may be more than a single mediator between the program and the outcome, or a series of cascading mediators that intervene and are causally related in sequence, between the program and outcome. According to these researchers, this does not imply that the entire “causal pathway” requires explanation through the mediator, as some of the effect may be direct.

According to McKinnon [93] the methodological and statistical challenge of investigating mechanisms of change has made methodology for assessing mediation an active research topic. Mediation analysis is a method to increase information obtained from a research study when measures of the mediating process are available. However, experimental studies in behavior change field rarely involve both manipulation of the mediator and measurement of

mediating variables. Only when this happens, mechanisms of behavior change may be investigated statistically. In this research, an intervention is designed to change mediating variables that are hypothesized to be causally related to a dependent variable. If the hypothesized relations are correct, a prevention or treatment program that substantially changes the mediating variables will in turn change the outcome. In both of these examples, a mechanism that transmits the effect of an independent variable on a dependent variable is first identified by theory and later tested in an experiment. McKinnon also pointed that the most widely used method to assess mediation is the causal steps approach outlined in the classic work of Baron and Kenny [91].

According to Baron and Kenny [91], four conditions (steps) must be met for a variable to be considered a mediator: (a) the predictor, must be significantly associated with the hypothesized mediator, (b) the predictor, must be significantly associated with the dependent measure (c) the mediator must be significantly associated with the dependent variable and (d) the impact of the predictor, on the dependent measure, is less after controlling for the mediator. Extending Baron and Kenny's [91] criteria for mediation to the context of randomized trials, Stice and colleagues [94] propose that the strongest case for mediation will be made when: (a) participants in the intervention condition show significantly greater changes on the outcome over time than controls (treatment condition predicts change in the outcome); (b) Participants in the intervention condition show significantly greater changes on the mediator over time than controls (treatment condition predicts change in the mediator); (c) change in the mediator over time is significantly correlated with change in the outcome over time in the intervention condition; (d) the predictive effect of intervention condition on change in the outcome, controlling for change in the mediator, is significantly reduced (for partial mediation) or eliminated (for complete mediation), relative to when the outcome is regressed only on intervention condition. Because human behaviors have a variety of causes, it is often

unrealistic to expect that a single mediator would be explained completely by an independent variable to dependent variable relation.

If there is an agreement between researchers regarding these general conditions, the same does not apply to a corollary of the Baron and Kenny's second condition, that there first has to be a significant relationship between the predictor and the dependent variable for a mediator to serve its mediating role. Kraemer et al. [86] defend that there is no need that the treatment first be shown effective overall in changing the outcome: "there may be zero overall effectiveness, but there may still be important mediator effects. In short mediator analyses may be just important for what seems an overall noneffective treatment. Most other approaches to testing mediation hypotheses focus not on the individual paths in the mediation model but instead on the product term (intervention to mediator X mediator to outcome), under the logic that this product, reflecting the indirect effect is equal to the difference between the total and direct effect [95]. Until recently, researchers wishing to test the significance of indirect effects had little option but to use Sobel's large-sample test. Now, however, developments in statistical theory provide alternative methods for testing direct and indirect effects in mediation models. One particularly useful approach is the bootstrap framework, which can be applied even when sample sizes are moderate or small, that is, in the range of 20–80 cases [96]. Bootstrapping is a nonparametric resampling procedure that does not impose the assumption of normality of the sampling distribution and a computationally intensive method that involves repeatedly sampling from the data set and estimating the indirect effect in each resampled data set. By repeating this process thousands of times, an empirical approximation of the sampling distribution of is built and used to construct confidence intervals for the indirect effect.

Articles III and IV of this Thesis, set within the context of a RCT, with a theory-based intervention designed to change mediating variables that are hypothesized to be causally related to the dependent variables, aimed at responding the Michie and Abraham's third question (how does the intervention work?), by exploring the hypothesized mediated mechanisms embedded in the chosen theoretical framework, following the above mentioned tenets.

According to McKinnon [93] conducting mediation analyses has several advantages: first it provides a check on whether the program produced a change in the construct(s) it was designed to change (e.g. if a program is designed to change norms, then program effects on normative measures should be found); second, mediation analyses results may suggest that certain program components need to be strengthened or measurements need to be improved, as failures to significantly change mediating variables occur either because the program was ineffective or the measures of the mediating construct(s) were not adequate; third, program effects on mediating variables in the absence of effects on outcome measures suggest that program effects on outcomes may emerge later or that the targeted constructs were not critical in changing outcomes. Furthermore, for Kraemer et al. [86] the identification of mediators may not only enhance treatment structure but also advance our understanding of the nature of behaviors. For example if a treatment has its effects by influencing a particular process, these findings establish the importance of this process in the maintenance of the behavior. Thus, understanding the mechanisms through which treatment operate can streamline and improve the program by focusing on effective components. Active therapeutic components could be intensified and refined whereas inactive or redundant elements could be discarded.

The importance of theory to practice

Clearly, there should be some theoretical basis and justification, some psychological plausibility in the selection of variables to be considered as possible mediators and attention to their validity and reliability, thus, the causal model to be tested needs to be conceptually plausible [89]. Michie and Abraham [88] pointed that atheoretical interventions fail to build on existing knowledge. In the absence of a theoretical underpinning, intervention design is derived from implicit theories that may omit psychological processes central to behavior change and so fail to optimize effectiveness. The generalization of such interventions is also limited if change mechanisms are poorly understood. Jeffery [97] defended that health behavior intervention lies at the interface between people and their environment. Interventionists change aspects of the environment (cues, information, behavioral contingencies) with the intention of producing changes in how people behave, thus, what is needed to advance health behavior intervention is theory that addresses relationships between modifiable aspects of the environment and behavior. Theory has been variously defined. The Oxford English Dictionary (online) defines a theory as a system of ideas, confirmed by observation or experiment, that explains a group of facts or phenomena. For Michie and Abraham [88] interventions can be regarded as theory-based when the theory used to interpret findings has two characteristics. First, it provides a clear account of hypothesized mechanisms or causal processes that generate behavior change. In other words, it describes psychological processes accounting for the initiation, re-direction or cessation of behavior achieved by the intervention. Second, the theory is supported by independent experimental work. Shrouf and Bolger [96] further argued that mediation models of intervention processes are useful for theory development and testing by allowing interesting associations to be decomposed into components that reveal possible causal mechanisms.

The discussion about the interplay between theory and intervention has a long history and much has been written and published. A special issue of the International Society of Behavioral Nutrition and Physical Activity (2004) aimed at delineate the problem, present the different perspectives on the issue, and suggest constructive steps researchers can take to move the field forward. Within this issue, Jeffery [98] argued that these theories focus primarily on psychological variables as predictors of people's motivation to change, but often fail to address people's abilities and opportunities to change. The dominant conceptual models guiding intervention development have been cognitive behavior models that have their origin in psychological theory. Those most often cited include the Health Belief Model [99], the Theory of Reasoned Action [100], Subjective Expected Utility Theory [101], Theory of Planned Behavior [102], Social Cognitive Theory [103], and the Transtheoretical Model [104]. All of these theories are concerned with how people make behavioral choices and the general idea is that people decide what to do base on the extent to which they expect that their choices will produce results that they value. Thus, although much of health behavior practice targets what people do rather than what they think, the logic of focusing on thoughts is that what people think about is the key to what they will do in the future. Unfortunately, in Jeffery's experience, the premise of cognitive theories has fallen short empirically in a number of ways. The cognitive schemata favored by most health behavior theories are difficult to measure, they do not predict behavioral outcomes very well, there is little evidence that they cause behavior, and they are hard to change directly. This led to a defense that a focus on the interface between the person and the environment as well as a return to the more classic learning theories might better inform weight loss interventions. Health behavior intervention lies at the interface between people and their environment. Interventionists change aspects of the environment (cues, information, behavioral contingencies) with the intention of producing changes in how people behave. In Jeffery's opinion, what is needed to advance health

behavior intervention is theory that addresses relationships between modifiable aspects of the environment and behavior. There is no doubt that cognitive processes are involved in these relationships. However, the extent to which current theories capture this is questionable.

For Rothman [105] only experimental research and increased theoretical and methodological clarity could accelerate the identification of effective behavior change techniques and the development of evidence-based practice in behavior change interventions, recognizing the importance of structured protocols to better apply theoretical constructs in intervention development. Indeed, when behavior change interventions consist of techniques based on empirically supported theory, then that theory provides an explanation of how the intervention works. This researcher suggested that improving the quality of evaluations and standardizing intervention evaluation reports could facilitate this process, and that improvements in both health behavior theory and intervention methods depend on each other. That is, theorists and interventionists “need to treat a theory as a dynamic entity whose form and value rests upon it being rigorously applied, tested and refined in both the laboratory and the field” (p.1). This opinion is shared by Brug [106], defending that more experimental research is necessary to test behavioral theories, which should not be viewed as fixed entities, but should be further refined as well as integrated. To this end, greater advantage needs to be taken of the opportunities that interventions afford for theory-testing and, moreover, the data generated by these activities need to stimulate and inform efforts to revise, refine, or reject theoretical principles. In particular, there is an emphasized need for experimental methods, clear descriptions of interventions and theoretical specificity

In line with the stated needs and opportunities, the first (introductory) of the four articles configured a study protocol, aimed at describing the 3-year randomized controlled trial in

terms of study design, recruitment, inclusion criteria, measurements, and a detailed description of the intervention (general format, goals for the participants, intervention curriculum, and main strategies based on the theoretical principles and rationale.

Self-determination theory as a theoretical framework for studying mediators of long-lasting behavior change

Few people, especially those treating or counseling persons with obesity, would argue against the importance of motivation as a predictor of treatment success. However, while current programs do a fair job of addressing the skills (the “how’s to”) of losing weight, comparatively less attention has been devoted to detailing the motivational processes involved, including a more qualitative analysis (the “whys”) of the psychological drive or energy needed for successfully sustained weight self-regulation. Why do some patients lose motivation and others do not, particularly after achieving weight loss and entering maintenance?

Motivation concerns energy, direction and persistence, all aspects of activation and intention. Motivation has been a central and perennial issue in the field of psychology and, for it is at the core of biological, cognitive, and social regulation. Perhaps more important, in the real world (and in exercise and health care settings), motivation is highly valued because of its consequences: Motivation produces outcomes. However, a default view of motivation reduced to its quantitative dimension could be a limiting factor in current weight loss interventions. With this regard, the conceptual framework provided by self-determination theory (SDT) [71, 107] could be useful in explaining long-term adherence by exploring the dynamics of motivation during the course of behavioral change.

Understanding the motivational basis of long-term weight management and exercise may require the adoption of a more general model of motivation than that offered by the behaviorist tradition, which focuses on controlling a person's behavior with rewards and punishments and on the external determinants of behaviors. It also requires adopting a model more general than that offered by the social cognitive tradition, characterized by a higher emphasis on expected outcomes and enhancing patients' sense of confidence or self-efficacy (quantity of motivation) but not focusing on the quality of motivation, sense of autonomy, and locus of causality [103]. SDT may provide such a model.

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In general SDT argues that theories of intentional behavior are too simplistic and mechanistic to provide a complete picture of human motivation [107]. Comprising four sub-theories (Basic needs theory; Cognitive evaluation theory; Organismic orientation theory; Causality orientation theory) SDT may shed some light on this subject and explain not only the origins of the “intention” constructs, but also their continued (or not) effect.

The sub-theories of SDT and their conceptual bounds in explaining sustained motivation and behavior

SDT is an approach to human motivation and personality that uses traditional empirical methods while employing an organismic metatheory that highlights the importance of humans' evolved inner resources for personality development and behavioral self-regulation [111].

Basic needs theory considers that just as humans have biological needs such as thirst and hunger, people also have the universal need to seek out and obtain experiences of self-determination, competence, and relatedness. These three essential and innate psychological needs form the basis of motivation: Competence refers to the need to know how to be able to produce behavioral outcomes, i.e. a propensity to have an effect on the environment as well as to attain valued outcomes within it [112]. Relatedness refers to the desire to feel connected to others—to love and care, and to be loved and cared for [113]. Self-determination refers to the need to experience oneself as initiator and regulator of one's actions. Thus, autonomy refers to volition—the organismic desire to self-organize experience and behavior and to have activity concordant with one's integrated sense of self [see, e.g.117-119].

These needs are conceptualized as organismic necessities rather than acquired motives. Like drive theorists defend they are considered to be innate rather than learned (and therefore to give motivational content to life) and their definition can be considered in organismic and functional terms. It assumes a fundamental human trajectory toward vitality, integration, and health. In other words, human needs specify the necessary conditions for psychological health or well-being and their satisfaction are thus hypothesized to be associated with the most effective functioning.

According to Deci and Ryan [71] the dramatic shift toward cognitive theories (around the 1960s) led to the concept of needs being repudiated and replaced by the concept of goals as the dominant motivational concept. The focus became the processes of goal selection and pursuit rather than the content of the goals being selected and pursued. The concept of valence (Psychological value) of outcomes was defined functionally (and thus was not related to need satisfaction), much as the concept of reinforcement had been defined functionally in operant psychology, ignoring the needs that had provided the underpinning of reinforcements in drive theories [e.g. 120]. SDT has, in contrast, maintained that a full understanding not only of goal-directed behavior, but also of psychological development and well-being, cannot be achieved without addressing the needs that give goals their psychological potency and that influence which regulatory processes direct people's goal pursuits. Thus, the concept of needs specified the *content* of motivation provided a substantive basis for the energization and direction of action (essential for understanding the *what*, i.e., content, and *why*, i.e., process, of goal pursuits).

To explain the meaning of needs in SDT, Deci and Ryan [71] consider not only the theoretical concept but also the **organismic-dialectical metatheory** that underlies it. The starting point for SDT, encapsulated in the organismic-dialectical metatheory, is the postulate that humans are active, growth-oriented organisms who are naturally inclined toward integration of their psychic elements into a unified sense of self and integration of themselves into larger social structures. In other words, SDT suggests that it is part of the adaptive design of the human organism to engage interesting activities, to exercise capacities, to pursue connectedness in social groups, and to integrate intrapsychic and interpersonal experiences into a relative unity. Thus, in addition to addressing issues related to the energization of human motivation by basic psychological needs, SDT also places importance on the social contexts that can affect motivated behavior, being a dialectic theory that views the environment as nurturing need-

satisfaction and motivation. Psychological needs must also be supported by the social context, because otherwise individuals will feel alienated and will not experience need satisfaction. This organismic-dialectical perspective further proposes that these natural organismic activities and the integrative propensities that coordinate them require fundamental nutriments, namely, ambient supports for experiencing competence, relatedness, and autonomy. At the heart of this perspective is the assertion that people develop through the process of organismic integration as they proactively engage their world, and the view of human behavior and experience in terms of the dialectic between the person and the environment- the interaction (and potential opposition) between the active organism striving for unity and autonomy and the social context that can be either nurturing or antagonistic toward the person's organismic tendencies.

According to Hagger [121] the argument that both internal events and social environments are important determinants of behavior is a shared similarity between SDT and the already mentioned cognitive theories of intentional behavior. The differences lie in the proximity and origin of the constructs that influence behavior. While theories of intention deal with more specific cognitive and affective determinants of action, SDT focuses on more general organismic conditions that rise to motivation and behavior, going beyond the cognitive representation of a future desired state to the "why" is this state desired and offering reasons "why" such social cognitive variables exist. With this regard, it is important to note that the important difference between theories of intentional behavior, that view motivation as varying in strength alone, and SDT, is that SDT is also concern with the form of **quality of motivation**. Indeed, although motivation is often treated as a singular construct, even superficial reflection suggests that people are moved to act by very different types of factors, with highly varied experiences and consequences. People can be motivated because they value an activity or because there is a strong external coercion. Comparisons between people whose

motivation is authentic (literally, self-authored or endorsed) and those who are merely externally controlled for an action, typically reveal that the former, relative to the latter, have more interest, excitement, and confidence, which in turn is manifested both as enhanced performance, persistence, and creativity [122, 123] as well as heightened vitality [124], self-esteem and general well-being [111]. This is so, even when people have the same level of perceived competence or self-efficacy for the activity. With this regard, Deci and Ryan [125] suggested that “by considering the perceived forces that move a person to act, SDT has been able to identify several distinct types of motivation, each of which has specifiable consequences for learning, performance, personal experience, and well-being.” (p.69).

Despite the fact that humans are liberally endowed with intrinsic motivational tendencies, the evidence is now clear that the maintenance and enhancement of this inherent propensity requires supportive conditions, as it can be fairly readily disrupted by various nonsupportive conditions. Thus, SDT examines the conditions that elicit and sustain, versus subdue and diminish this innate propensity. **Cognitive evaluation theory** is a subtheory of SDT that was developed to explain the effects of intrinsic motivation on behaviors and how social contexts affect motivation [107]. Thus it is framed in terms of social and environmental factors that facilitate versus undermine intrinsic motivation, using language that reflects the assumption that intrinsic motivation, being inherent, will be catalyzed when individuals are in conditions that conduce toward its expression. Additional propositions concern the functional significance ascribed to external and intrapersonal events that vary in terms of their informational, controlling, or amotivating nature. In brief, events interpreted as informational rather than controlling or amotivating, promote greater endorsement of intrinsic motivation

via the fulfillment of autonomy and competence needs [107]. The theory argues that social-contextual events (e.g., feedback, communications, rewards) that conduce toward feelings of competence during action can enhance intrinsic motivation for that action. Accordingly, optimal challenges, effectance-prorooting feedback, and freedom from demeaning evaluations were all found to facilitate intrinsic motivation. Cognitive Evaluation Theory further specifies, that feelings of competence will not enhance intrinsic motivation unless accompanied by a sense of autonomy or, in attributional terms, by an internal perceived locus of causality [117]. Thus, people must not only experience competence or efficacy, they must also experience their behavior as self-determined for intrinsic motivation to be in evidence.

Hagger [121] alerts to the fact that although cognitive evaluation theory and the concept of intrinsic motivation have attracted a great deal of scientific interest, it is important to realize that it only applies to behaviors and tasks that are potentially inherently interesting. The theory does not apply to behaviors unlikely to be intrinsically motivating. To understand the motivation of non-intrinsically motivated behaviors, **organismic integration theory**, and the internalization process (by which extrinsically motivated behaviors can become self-determined) should be acknowledged.

From amotivation (referring to a person's lack of intentionality and sense of personal causation) to completely self-determined behavior, several forms of regulation, can be acknowledged. Unlike some perspectives that view extrinsically motivated behavior as invariably nonautonomous, SDT proposes that extrinsic motivation can vary greatly in its relative autonomy [126, 127]. Four regulatory styles, ranging from external to integrated regulation represent different types of extrinsic motivation. This distinct, yet adjacent, motivational regulatory forms are represented as a continuum characterized in terms of the

degree to which the regulation of a behavior has been internalized, so that it is engaged in with a true sense of volition and choice. Motivation is autonomous to the extent that a person's perceived locus of causality is *internal* (i.e. the perceived source of initiation and regulation for motivated behaviors emanates from the self). Motivation is controlled to the extent that people act because they feel pressured or compelled to do so, either by others or by themselves, and this involves having an *external* perceived locus of causality. See **table 1** for an integrated example applied to exercise settings.

Table1. Examples of the quality of motivation (Source: Rodgers & Loitz, [128])

Quality of Motivation	Amotivation	Extrinsic Motivation				Intrinsic Motivation
Type of regulation	nonregulation	External regulation	introjected regulation	identified regulation	integrated regulation	Intrinsic regulation
Quality of behavior	Completely controlled	Externally controlled	internally controlled	mixture of external control and internal values	behavior is seen as consistent with personal goals and values	Completely volitional; internally controlled
Description of regulation	basically a complete lack of motivation to perform a behavior; no value seen in activity at all; sometimes happens when activity is forced (e.g., PE classes)	behaviors performed for reasons not related to the behavior, like payment or valuable rewards or social recognition or improved physique	behavior is based on internally managed rewards such as feelings of pride or avoiding feelings of guilt for not doing a behavior	behavior is based on personal value of the purpose and outcomes	behavior is associated with identity; behavior is more stable	behavior is performed for enjoyment and no other reward or outcome external to the actual performance of the behavior
Long-term effects in exercise	associated with negative outcomes such as negative self-image, negative emotions	sometimes useful for short-term adherence but not long term; associated with dropout and negative emotions	useful for short-term adherence; not associated with positive emotions or positive self-image	associated with long-term adherence and some positive emotions like personal satisfaction	associated with good long-term adherence; associated with positive self-image and self-congruence; feeling "together" and consistent	associated with best long-term adherence; very positive outcomes including fun and enjoyment, high personal satisfaction, and feelings of vitality
Example motives	I would not do this if someone didn't make me or if I had a choice	to look good; to lose weight; to get a reward (like a free TV for joining)	because I think I should; because I feel guilty if I don't; to avoid disapproval	for personal values like good health; to increase strength and fitness (which are still separate outcomes from the exercise itself)	because it's consistent with my self-image; "I am an active person"; "I am an healthy person"; "I am an exerciser"	because I love exercise; it's fun and I feel great when I exercise
Competence	Do not feel at all competent	feel a little competent	feel a little competent	feel competent	feel competent	feel very competent
Autonomy	No autonomy; no sense of having chosen to do the behavior	very little autonomy; reason for doing the behavior is outside the self; to get something	very little autonomy; reason for doing the behavior is to please others	moderate autonomy; feel sense of having chosen to engage in the behavior	high autonomy; definitely choose to engage in the behavior	very high autonomy; would choose to do this behavior anytime
Relatedness	No relatedness; do not feel connected to others in context of behavior; possibly feel alienated or unwelcome	very little or negative relatedness; do not feel connected to others in context; feel pressured to be in context	very little or negative relatedness; do not feel connected to others in context; feel pressured from others to be in context	positive relatedness; feel connected to others in context; sense of belonging	more positive relatedness; feel meaningfully connected to others in context; feel comfortable and feel belonging	high relatedness (mostly but not strictly necessary for runners, e.g., others in context might not matter); for group situations; feel meaningfully connected to others in context
Things the instructor can do to support these motivations	force people to participate; give no explanations; provide a controlling atmosphere	focus on external motives; weight loss, looking good, retting a date, proving themselves	focus on social pressure and guilt; "won't your partner be impressed if you do this"; "you'll feel bad if you don't finish"; "you'll feel good if you do finish"; these are external contingencies	focus on personal values; "exercise promotes health"; "exercise increases your strength"; "exercise is a good activity"; you feel good when you exercise	focus on personal identity; "think of yourself as exerciser"; "you are a health-conscious person, health conscious people exercise"	focus on fun and enjoyment of actually performing the exercise

External regulation. This is the classic extrinsic motivation in which people's behavior is controlled by specific external contingencies. People behave to attain a desired consequence such as rewards or to avoid a threatened punishment. In SDT, external regulation is considered controlling, and externally regulated behaviors are predicted to be contingency dependent in that they show poor maintenance and remove once contingencies are withdrawn [107].

Introjected regulation. Whereas with external regulation the control of behavior comes from contingent consequences that are administered by others, in this type of regulation the contingent consequences are administered by the individuals to themselves. The prototypic examples are contingent self-worth (pride) or threats of guilt and shame. Introjection represents a partial internalization in which regulations are in the person but have not really become part of the integrated set of motivations, cognitions, and affects that constitute the *self*. Because introjected regulations have not been assimilated to the self, the resulting behaviors are not self-determined [71].

Identification. This is the process through which people recognize and accept the underlying value of a behavior. The internalization is fuller than with introjection and the resulting behavior would be more autonomous, although it would still be extrinsically motivated because would still be instrumental (to attain the identified value), rather than being done solely as a source of spontaneous enjoyment and satisfaction. Regulations based on identifications, because the self has endorsed them, are expected to be better maintained and to be associated with higher commitment and performance [71].

Integration. This is the fullest, most complete, form of internalization of extrinsic motivation, for it not only involves identifying with the importance of behaviors, but also integrating those

identifications with other aspects of the self by bringing them into harmony or coherence with other aspects of their values and identity [129].

External and Introjected configure controlled forms of behavioral regulation. Identified and integrated, although extrinsic are more autonomously regulated. Autonomous behavior is an expression of one's self and is undertaken with a full sense of choice, accompanied by an internal perceived locus of causality and a sense of true volition. Importantly, according to this theory, autonomously motivated behaviors are more likely to result in meaningful, long-lasting changes. Conversely, behaviors that are controlled by rewards and punishments or by self-imposed pressures are predicted to last only as long as the contingencies or pressures remain in place [119, 125].

The self-determination continuum is underpinned by the extent to which people experience the satisfaction of three basic psychological needs: competence, autonomy, and relatedness. The theory proposes that by targeting these three needs and by developing contexts that satisfy them, we can produce more self-determined motivation. *Internalization*, an active, natural process, in which individuals attempt to transform socially sanctioned mores or requests into personally endorsed values and self-regulations [111], is conceptualized as the process through which individuals assimilate and reconstitute formerly external regulations. For Deci and Ryan [71] when the internalization process functions optimally, people will identify with the importance of social regulations and assimilate the regulation of behavior as their own.

According to SDT's basic tenets, successful maintenance of weight reduction would occur when people chose eating and exercise behaviors because they personally value weight loss maintenance and its health benefits. Lasting behavior change necessary for maintenance depends not on complying with demands for change, but rather on accepting the regulation for change as one's own. In other words, it requires internalizing values and regulation of relevant

behaviors and then integrating them with one's sense of self, so they become the basis for autonomous regulation [130]. Accordingly, successful weight loss and long-term maintenance would not be achieved if reasons for it were mostly controlling (e.g., because the doctor insisted, or based on a strong desire to be thin, according to social norms). Being autonomous in one's relevant actions, that is, having an internal perceived locus of causality is the crucial predictor of maintained behavior change [131].

In a recent review conducted by Wilson [132] it is argued that one attractive feature of any theory concerns the practical recommendations conferred for motivating behavioral change within a given context such as exercise. In this vein, advocates of SDT have long extolled the virtues of creating “adaptive” environments via providing sociocontextual supports that promote the fulfillment of basic needs, facilitate more self-determined regulation of behavior, and contribute to overall feelings of eudemonic well-being and health [125, 133]. The specific dimensions of the social environment have been forwarded within the SDT framework as catalysts of behavioral change for practitioners to consider. These dimensions are subject of a detailed explanation throughout chapters 3, 4 and 5 of this Thesis. Indeed, also according to Wilson [132], in comparison to other aspects of the SDT framework, the research focus on manipulating sociocontextual variables within the framework forwarded by SDT has been limited. Thus a major focus of this Thesis will be to address this limitation in the field of physical activity promotion in the context of obesity treatment.

In a review examining the applicability of the SDT framework to exercise contexts, Hagger & Chatzisarantis [134] concluded that, by accounting for the quality of motivation regulating behavior, as well as the processes that facilitate motivational development, SDT holds considerable appeal for understanding “why” people initiate, persist, and terminate their involvement in various physical activities. Several other researchers [72, 132, 135-137] share the idea that the approach to understanding human motivation and development provided

within SDT offers a macrolevel framework for addressing a number of important questions pertaining to exercise participation. SDT holds considerable appeal as an approach for understanding both initiation and persistence issues in exercise, given that the theory specifies both the nature and function of motivation, as well as the sociocontextual conditions that foster (or forestall) motivational development and long-term adherence.

In sum, the background exposed pointed the need for better research designs that allow a deeper understanding of the mechanisms associated with improved weight loss and/or maintenance, namely those related to physical activity/exercise. Indeed, individual response to exercise/physical activity is determined by a variety of factors which, to a large extent, are *independent* of the dose of exercise/physical activity which is prescribed. Thus, it is important to study the reasons why so many overweight or at risk individuals are unable or unwilling to become more active, and especially investigating how can they be better supported in adopting physical activity for life. Experimental research and increased theoretical and methodological clarity could accelerate the identification of effective behavior change techniques and the development of evidence-based-practices. As many reviews have shown [132, 134, 138], one theoretical perspective that appears useful for understanding motivation and adherence to exercise is SDT, and variables specifically related to motivation and self-regulation for physical activity appear to be predictors of success, shedding some light into the underlying mechanisms of change.

References

1. Allison, D.B., M. Downey, R.L. Atkinson, C.J. Billington, G.A. Bray, R.H. Eckel, E.A. Finkelstein, M.D. Jensen, and A. Tremblay, *Obesity as a disease: a white paper on evidence and arguments commissioned by the Council of the Obesity Society*. Obes (Silver Spring), 2008. 16(6): p. 1161-77.
2. Bray, G.A., *Medical consequences of obesity*. J Clin Endocrinol Metab, 2004. 89: p. 2583-2589.
3. USDHHS, *Clinical Guidelines on the identification, evaluation, and treatment of overweight and obesity in adults*. 1998, NIH-National Heart, Lung, and Blood Institute. Bethesda, MD.
4. Kopelman, P.G., *Obesity as a medical problem*. Nature, 2000. 404 (6778): p. 635-43.
5. Willett, W.C., J.E. Manson, M.J. Stampfer, G.A. Colditz, B. Rosner, F.E. Speizer, and C.H. Hennekens, *Weight, weight change, and coronary heart disease in women. Risk within the 'normal' weight range*. Jama, 1995. 273(6): p. 461-5.
6. Willett, W.C., W.H. Dietz, and G.A. Colditz, *Guidelines for healthy weight*. N Engl J Med, 1999. 341(6): p. 427-34.
7. Peters, J.C., H.R. Wyatt, W.T. Donahoo, and J.O. Hill, *From instinct to intellect: the challenge of maintaining healthy weight in the modern world*. Obes Rev, 2002. 3(2): p. 69-74.
8. Prentice, A. *An Ancient Metabolism in a Modern World*. in *European Association for the Study of Obesity*:. 2001. Vienna, Austria.
9. Haslam, D., *Obesity: a medical history*. Obes Rev, 2007. 8 (1): p. 31-6.
10. Flegal, K.M., M.D. Carroll, R.J. Kuczmarski, and C.L. Johnson, *Overweight and obesity in the United States: prevalence and trends, 1960-1994*. Int J Obes Relat Metab Disord, 1998. 22(1): p. 39-47.
11. Kuczmarski, R.J., K.M. Flegal, S.M. Campbell, and C.L. Johnson, *Increasing prevalence of overweight among US adults. The National Health and Nutrition Examination Surveys, 1960 to 1991*. Jama, 1994. 272(3): p. 205-11.
12. James, W.P., *The epidemiology of obesity: the size of the problem*. J Intern Med, 2008. 263(4): p. 336-52.
13. WHO, *The challenge of obesity in the WHO European Region and the strategies for response*. 2007, World Health Organization: Copenhagen, Denmark.

14. do Carmo, I., O. Dos Santos, J. Camolas, J. Vieira, M. Carreira, L. Medina, L. Reis, J. Myatt, and A. Galvao-Teles, *Overweight and obesity in Portugal: national prevalence in 2003-2005*. *Obes Rev*, 2008. 9(1): p. 11-9.
15. do Carmo, I., O. dos Santos, J. Camolas, J. Vieira, M. Carreira, L. Medina, L. Reis, and A. Galvao-Teles, *Prevalence of obesity in Portugal*. *Obes Rev*, 2006. 7(3): p. 233-7.
16. Marques-Vidal, P. and C.M. Dias, *Trends in overweight and obesity in Portugal: the National Health Surveys 1995-6 and 1998-9*. *Obes Res*, 2005. 13(7): p. 1141-5.
17. Pi-Sunyer, F.X., *Medical hazards of obesity*. *Ann Intern Med*, 1993. 119(7): p. 655-60.
18. Sturm, R. and K.B. Wells, *Does obesity contribute as much to morbidity as poverty or smoking?* *Public Health*, 2001. 115(3): p. 229-35.
19. Allison, D.B. and F.X. Pi-Sunyer, *Obesity treatment: Examining the premises*. *Endocr Pract*, 1995. 1: p. 353-364.
20. Puhl, R. and K.D. Brownell, *Bias, discrimination, and obesity*. *Obes Res*, 2001. 9(12): p. 788-805.
21. Cash, T.F., *Body image: past, present, and future*. *Body Image*, 2004. 1(1): p. 1-5.
22. Thompson, J.K., *Body image, eating disorders, and obesity: An integrative guide for assessment and treatment*. 1996, Washington, D.C.: American Psychological Association.
23. Friedman, K.E., S.K. Reichmann, P.R. Costanzo, and G.J. Musante, *Body image partially mediates the relationship between obesity and psychological distress*. *Obes Res*, 2002. 10(1): p. 33-41.
24. Puhl, R.M., C.A. Moss-Racusin, and M.B. Schwartz, *Internalization of weight bias: Implications for binge eating and emotional well-being*. *Obes (Silver Spring)*, 2007. 15(1): p. 19-23.
25. Doll, H.A., S.E. Petersen, and S.L. Stewart-Brown, *Obesity and physical and emotional well-being: associations between body mass index, chronic illness, and the physical and mental components of the SF-36 questionnaire*. *Obes Res*, 2000. 8(2): p. 160-70.
26. Myers, A. and J.C. Rosen, *Obesity stigmatization and coping: relation to mental health symptoms, body image, and self-esteem*. *Int J Obes Relat Metab Disord*, 1999. 23: p. 221-30.

27. Sarwer, D.B., T.A. Wadden, and G.D. Foster, *Assessment of body image dissatisfaction in obese women: specificity, severity, and clinical significance*. J Consult Clin Psychol, 1998. 66: p. 651-4.
28. Hippocrates, *De Flatibus*. 400 BC.
29. DPP, *The Diabetes Prevention Program (DPP): description of lifestyle intervention*. Diabetes Care, 2002. 25(12): p. 2165-71.
30. Knowler, W.C., E. Barrett-Connor, S.E. Fowler, R.F. Hamman, J.M. Lachin, E.A. Walker, and D.M. Nathan, *Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin*. N Engl J Med, 2002. 346(6): p. 393-403.
31. Tuomilehto, J., J. Lindstrom, J.G. Eriksson, T.T. Valle, H. Hamalainen, P. Ilanne-Parikka, S. Keinanen-Kiukaanniemi, M. Laakso, A. Louheranta, M. Rastas, V. Salminen, and M. Uusitupa, *Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance*. N Engl J Med, 2001. 344(18): p. 1343-50.
32. Pi-Sunyer, X., G. Blackburn, F.L. Brancati, G.A. Bray, R. Bright, J.M. Clark, J.M. Curtis, M.A. Espeland, J.P. Foreyt, K. Graves, S.M. Haffner, B. Harrison, J.O. Hill, E.S. Horton, J. Jakicic, R.W. Jeffery, K.C. Johnson, S. Kahn, D.E. Kelley, A.E. Kitabchi, W.C. Knowler, C.E. Lewis, B.J. Maschak-Carey, B. Montgomery, D.M. Nathan, J. Patricio, A. Peters, J.B. Redmon, R.S. Reeves, D.H. Ryan, M. Safford, B. Van Dorsten, T.A. Wadden, L. Wagenknecht, J. Wesche-Thobaben, R.R. Wing, and S.Z. Yanovski, *Reduction in weight and cardiovascular disease risk factors in individuals with type 2 diabetes: one-year results of the look AHEAD trial*. Diabetes Care, 2007. 30(6): p. 1374-83.
33. Wadden, T.A. and M.L. Butryn, *Behavioral treatment of obesity*. Endocrinol Metab Clin North Am, 2003. 32(4): p. 981-1003.
34. Powell, L., J. Calvin III, and J. Calvin jr., *Effective obesity treatments*. Am Psychol, 2007. 62(3): p. 234-246.
35. Wing, R.R. and S. Phelan, *Long-term weight loss maintenance*. Am J Clin Nutr, 2005. 82(1): p. 222S-225S.
36. Jeffery, R., L. Epstein, G. Wilson, A. Drewnowski, A. Stunkard, R. Wing, and D. Hill, *Long term maintenance of weight loss: current status*. Health Psychol, 2000. 1: p. 5-16.

37. Wing, R. and J. Hill, *Successful Weight Loss Maintenance*. An Rev Nut, 2001. 21: p. 323-341.
38. Wadden, T.A., G.D. Foster, K.A. Letizia, and J.L. Mullen, *Long-term effects of dieting on resting metabolic rate in obese outpatients*. Jama, 1990. 264(6): p. 707-11.
39. Rosenbaum, M., E.M. Murphy, S.B. Heymsfield, D.E. Matthews, and R.L. Leibel, *Low dose leptin administration reverses effects of sustained weight-reduction on energy expenditure and circulating concentrations of thyroid hormones*. J Clin Endocrinol Metab, 2002. 87(5): p. 2391-4.
40. Cummings, D.E., D.S. Weigle, R.S. Frayo, P.A. Breen, M.K. Ma, E.P. Dellinger, and J.Q. Purnell, *Plasma ghrelin levels after diet-induced weight loss or gastric bypass surgery*. N Engl J Med, 2002. 346(21): p. 1623-30.
41. Schwartz, M.W., S.C. Woods, D. Porte, Jr., R.J. Seeley, and D.G. Baskin, *Central nervous system control of food intake*. Nature, 2000. 404(6778): p. 661-71.
42. Brownell, K.D. and K.B. Horgen, eds. *Food Fight: The Inside Story of America's Obesity Crisis and What We Can Do About It*. 2003: Chicago, IL.
43. Teixeira, P.J., S.B. Going, L.B. Sardinha, and T.G. Lohman, *A review of psychosocial pre-treatment predictors of weight control*. Obes Rev, 2005. 6(1): p. 43-65.
44. Teixeira, P.J., M.N. Silva, S.R. Coutinho, A.L. Palmeira, J. Mata, P.N. Vieira, E.V. Carraca, T.C. Santos, and L.B. Sardinha, *Mediators of Weight Loss and Weight Loss Maintenance in Middle-aged Women*. Obesity, 2009. 18: p.725-735.
45. Caspersen, C.J., K.E. Powell, and G.M. Christenson, *Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research*. Public Health Reports, 1985. 100: p. 126-131.
46. Andersen, R.E., T.A. Wadden, S.J. Bartlett, B. Zemel, T.J. Verde, and S.C. Franckowiak, *Effects of lifestyle activity vs structured aerobic exercise in obese women: a randomized trial*. Jama, 1999. 281(4): p. 335-40.
47. Donnelly, J.E., S.N. Blair, J.M. Jakicic, M.M. Manore, J.W. Rankin, and B.K. Smith, *American College of Sports Medicine Position Stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults*. Med Sci Sports Exerc, 2009. 41(2): p. 459-71.
48. USDHHS, *Physical Activity Guidelines Advisory Committee Report*. 2008, Department of Health and Human Services: Washington, DC: U.S.

49. Lyznicki, J.M., D.C. Young, J.A. Riggs, and R.M. Davis, *Obesity: assessment and management in primary care*. Am Fam Physician, 2001. 63(11): p. 2185-96.
50. Klem, M.L., R.R. Wing, M.T. McGuire, H.M. Seagle, and J.O. Hill, *A descriptive study of individuals successful at long-term maintenance of substantial weight loss*. Am J Clin Nutr, 1997. 66(2): p. 239-46.
51. Kayman, S., W. Bruvold, and J.S. Stern, *Maintenance and relapse after weight loss in women: behavioral aspects*. Am J Clin Nutr, 1990. 52(5): p. 800-7.
52. Jeffery, R.W., W.M. Bjornson-Benson, B.S. Rosenthal, R.A. Lindquist, C.L. Kurth, and S.L. Johnson, *Correlates of weight loss and its maintenance over two years of follow-up among middle-aged men*. Prev Med, 1984. 13(2): p. 155-68.
53. Pavlou, K.N., S. Krey, and W.P. Steffee, *Exercise as an adjunct to weight loss and maintenance in moderately obese subjects*. Am J Clin Nutr, 1989. 49(5): p. 1115-23.
54. Jeffery, R.W., R.R. Wing, N.E. Sherwood, and D.F. Tate, *Physical activity and weight loss: does prescribing higher physical activity goals improve outcome?* Am J Clin Nutr, 2003. 78(4): p. 684-9.
55. Jakicic, J.M., S.A. Jaramillo, A. Balasubramanyam, B. Bancroft, J.M. Curtis, A. Mathews, M. Pereira, J.G. Regensteiner, and P.M. Ribisl, *Effect of a lifestyle intervention on change in cardiorespiratory fitness in adults with type 2 diabetes: results from the Look AHEAD Study*. Int J Obes (Lond), 2009. 33(3): p. 305-16.
56. Jakicic, J.M., B.H. Marcus, K.I. Gallagher, M. Napolitano, and W. Lang, *Effect of exercise duration and intensity on weight loss in overweight, sedentary women: a randomized trial*. Jama, 2003. 290(10): p. 1323-30.
57. Fogelholm, M. and K. Kukkonen-Harjula, *Does physical activity prevent weight gain--a systematic review*. Obes Rev, 2000. 1(2): p. 95-111.
58. Catenacci, V.A., L.G. Ogden, J. Stuht, S. Phelan, R.R. Wing, J.O. Hill, and H.R. Wyatt, *Physical activity patterns in the National Weight Control Registry*. Obes (Silver Spring), 2008. 16(1): p. 153-61.
59. Jakicic, J.M., C. Winters, W. Lang, and R.R. Wing, *Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss, and fitness in overweight women: a randomized trial*. Jama, 1999. 282(16): p. 1554-60.
60. Mekary, R.A., D. Feskanich, S. Malspeis, F.B. Hu, W.C. Willett, and A.E. Field, *Physical activity patterns and prevention of weight gain in premenopausal women*. Int J Obes (Lond), 2009. 33(9): p. 1039-47.

61. Wadden, T.A., R.A. Vogt, R.E. Andersen, S.J. Bartlett, G.D. Foster, R.H. Kuehnel, J. Wilk, R. Weinstock, P. Buckenmeyer, R.I. Berkowitz, and S.N. Steen, *Exercise in the treatment of obesity: effects of four interventions on body composition, resting energy expenditure, appetite, and mood*. *J Consult Clin Psychol*, 1997. 65(2): p. 269-77.
62. Wadden, T.A., R.A. Vogt, G.D. Foster, and D.A. Anderson, *Exercise and the maintenance of weight loss: 1-year follow-up of a controlled clinical trial*. *J Consult Clin Psychol*, 1998. 66(2): p. 429-33.
63. Teixeira, P.J., R.J. Stubbs, N.A. King, S. Whybrow, and J. Blundell, *Exercise and Management of Overweight and Obesity*, in *Exercise and Chronic Disease*, J. Saxton, Editor. (in press). Routledge, London.
64. Ballor, D.L. and E.T. Poehlman, *Exercise-training enhances fat-free mass preservation during diet-induced weight loss: a meta-analytical finding*. *Int J Obes Relat Metab Disord*, 1994. 18(1): p. 35-40.
65. Elia, M., R.J. Stubbs, and C.J. Henry, *Differences in fat, carbohydrate, and protein metabolism between lean and obese subjects undergoing total starvation [see comments]*. *Obes Res*, 1999. 7(6): p. 597-604.
66. Elia, M., R. Stratton, and R.J. Stubbs, *Techniques for the study of energy balance in man*. *Proceedings of the Nutrition Society*, 2003. 62: p. 529-537.
67. Smith, S.R., L. de Jonge, J.J. Zachwieja, H. Roy, T. Nguyen, J. Rood, M. Windhauser, J. Volaufova, and G.A. Bray, *Concurrent physical activity increases fat oxidation during the shift to a high-fat diet*. *Am J Clin Nutr*, 2000. 72(1): p. 131-8.
68. Baker, C.W. and K.D. Brownell, *Physical Activity and Maintenance of Weight Loss: Physiological and Psychological Mechanisms*, in *Physical Activity and Obesity*, C. Bouchard, Editor. 2000, Human Kinetics: Champaign, IL. p. 311-328.
69. Martins, C., L. Morgan, and H. Truby, *A review of the effects of exercise on appetite regulation: an obesity perspective*. *Int J Obes (Lond)*, 2008. 32(9): p. 1337-47.
70. Mata, J., M.N. Silva, P.N. Vieira, E.V. Carraca, A.M. Andrade, S.R. Coutinho, L.B. Sardinha, and P.J. Teixeira, *Motivational "spill-over" during weight control: Increased self-determination and exercise intrinsic motivation predict eating self-regulation*. *Health Psychol*, 2009. 28(6): p. 709-16.
71. Deci, E. and Ryan, R. *The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior*. *Psychol Inquiry*, 2000. 11(4): p. 227-268.

72. Markland, D., *The mediating role of behavioural regulations in the relationship between perceived body size discrepancies and physical activity among adult women*. *Hellen J Psychol*, 2009. 6: p. 169-182.
73. Teixeira, P.J., S.B. Going, L.B. Houtkooper, E.C. Cussler, L.L. Metcalfe, R.M. Blew, L.B. Sardinha, and T.G. Lohman, *Exercise motivation, eating, and body image variables as predictors of weight control*. *Med Sci Sports Exerc*, 2006. 38(1): p. 179-88.
74. King, N.A., M. Hopkins, P. Caudwell, R.J. Stubbs, and J.E. Blundell, *Beneficial effects of exercise: shifting the focus from body weight to other markers of health*. *Br J Sports Med*, 2009. 43(12): p. 924-7.
75. Spiegel, A.M. and B.M. Alving, *Executive summary of the Strategic Plan for National Institutes of Health Obesity Research*. *Am J Clin Nut*, 2005. 82(1): p. 211S-214S.
76. Eurobarometer, S., *Sport and Physical Activity*. 2010, 334 / Wave 72.3: TNS Opinion & Social.
77. Abu-Omar, K. and A. Rutten, *Relation of leisure time, occupational, domestic, and commuting physical activity to health indicators in Europe*. *Prev Med*, 2008. 47(3): p. 319-23.
78. Varo, J.J., M.A. Martinez-Gonzalez, J. De Irala-Estevez, J. Kearney, M. Gibney, and J.A. Martinez, *Distribution and determinants of sedentary lifestyles in the European Union*. *Inter J Epid*, 2003. 32(1): p. 138-46.
79. Martinez-Gonzalez, M.A., J.J. Varo, J.L. Santos, J. De Irala, M. Gibney, J. Kearney, and J.A. Martinez, *Prevalence of physical activity during leisure time in the European Union*. *Med Sci Sport Exerc*, 2001. 33(7): p. 1142-6.
80. Instituto do Desporto de Portugal, *Observatório Nacional da Actividade Física - Livro Verde da Actividade Física*. 2010, IDP: Lisboa.
81. Dunn, A.L., B.H. Marcus, J.B. Kampert, M.E. Garcia, H.W. Kohl, 3rd, and S.N. Blair, *Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial*. *Jama*, 1999. 281(4): p. 327-34.
82. Teixeira, P.J., M.N. Silva, S.R. Coutinho, A.L. Palmeira, J. Mata, P.N. Vieira, E.V. Carraca, T.C. Santos, and L.B. Sardinha, *Mediators of Weight Loss and Weight Loss Maintenance in Middle-aged Women*. *Obesity*. 18: p.725-735.

83. Kraemer, H.C., G.T. Wilson, C.G. Fairburn, and W.S. Agras, *Mediators and moderators of treatment effects in randomized clinical trials*. Arch Gen Psych, 2002. 59(10): p. 877-83.
84. Friedman, M.A. and K.D. Brownell, *Psychological correlates of obesity: moving to the next research generation*. Psychol Bull, 1995. 117(1): p. 3-20.
85. Moher, D., K.F. Schulz, and D.G. Altman, *The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomised trials*. Lancet, 2001. 357(9263): p. 1191-4.
86. Kraemer, H.C., G.T. Wilson, C.G. Fairburn, and W.S. Agras, *Mediators and moderators of treatment effects in randomized clinical trials*. Archiv Gen Psych, 2002. 59(10): p. 877-83.
87. Oakley, A., D. Fullerton, J. Holland, S. Arnold, M. France-Dawson, P. Kelley, and S. McGrellis, *Sexual health education interventions for young people: a methodological review*. Bmj, 1995. 310(6973): p. 158-62.
88. Michie, S. and C. Abraham, *Interventions to change health behaviours: evidence-based or evidence-inspired?* Psychol Health, 2004. 19: p. 29-49.
89. Bauman, A.E., J.F. Sallis, D.A. Dzewaltowski, and N. Owen, *Toward a better understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders*. Am J Prev Med, 2002. 23(2): p. 5-14.
90. Kaplan, R., *Should medicare reimburse providers for weight loss interventions?* American Psychol, 2007. 62(3): p. 217-219.
91. Baron, R.M. and D.A. Kenny, *The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations*. J Pers Soc Psychol Bul, 1986. 51: p. 1173-1182.
92. MacKinnon, D.P., C.M. Lockwood, and J. Williams, *Confidence limits for the indirect effect: distribution of the product and resampling methods*. Mult Behav Res, 2004. 39: p. 99-128.
93. MacKinnon, D.P., A.J. Fairchild, and M.S. Fritz, *Mediation analysis*. Annu Rev Psychol, 2007. 58: p. 593-614.
94. Stice, E., K. Presnell, J. Gau, and H. Shaw, *Testing mediators of intervention effects in randomized controlled trials: An evaluation of two eating disorder prevention programs*. J Consult Clin Psychol, 2007. 75(1): p. 20-32.

95. Preacher, K.J., D.D. Rucker, and A.F. Hayes, *Addressing moderated mediation hypotheses: Theory, methods, and prescriptions*. *Mult Behav Res*, 2007. 42: p. 185-227.
96. Shrout, P.E. and N. Bolger, *Mediation in experimental and nonexperimental studies: New procedures and recommendations*. *Psychol Met*, 2002. 7: p. 422-445.
97. Jeffery, R.W., K.M. Kelly, A.J. Rothman, N.E. Sherwood, and K.N. Boutelle, *The weight loss experience: a descriptive analysis*. *Ann Behav Med*, 2004. 27(2): p. 100-6.
98. Jeffery, R.W., *How can Health Behavior Theory be made more useful for intervention research?* *Int J Behav Nutr Phys Act*, 2004. 1(1): p. 10-15.
99. Becker, M.H., *The health belief model and personal health behavior*. Health Education Monographs. Vol. 2. 1974.
100. Ajzen, I. and M. Fishbein, *Understanding attitudes and predicting social behavior*. 1980, Englewood Cliffs, NJ: Prentice Hall.
101. Edwards, W., *The theory of decision making*. *Psychol Bull*, 1954. 51: p. 380-417.
102. Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckman (Eds.), *Action-control: From cognition to behavior*. Heidelberg: Springer
103. Bandura, A., *Social Foundations of Thought and Action: A Social Cognitive Theory*. 1986, Englewoods Cliffs: Prentice-Hall.
104. Prochaska, J.O. and W.F. Velicer, *The transtheoretical model of health behavior change*. *Am J Health Promot*, 1997. 12: p. 38-48.
105. Rothman, A.J., *"Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory*. *Int J Behav Nutr Phys Act*, 2004. 1(1): p. 11-18.
106. Brug, J., *Order is needed to promote linear or quantum changes in nutrition and physical activity behaviors: a reaction to 'A chaotic view of behavior change' by Resnicow and Vaughan*. *Int J Behav Nutr Phys Act*, 2006. 3: p. 29-33.
107. Deci, E. and R. Ryan, *Intrinsic motivation and self-determination in human behavior*. 1985, New York: Plenum.
108. Rosenstock, I.M., *Historical origins of the health belief model*. Health Education Monographs. Vol. 2. 1974: Health Education Monographs.

109. Rodgers, W. and L.R. Brawley, *Using both self-efficacy theory and the theory of planned behavior to discriminate adherers and dropouts from structured programs*. J Appl Sport Psychol, 1993. 5: p. 195-206.
110. Ajzen, I., *From intentions to actions: a theory of planned behavior*, in *Action-control: from cognition to behavior*, J. Kuhl and J. Beckman, Editors. 1985, Springer: Heidelberg.
111. Ryan, R.M., E.L. Deci, and W.S. Grolnick, *Autonomy, relatedness, and the self: Their relation to development and psychopathology*, in *Developmental psychopathology*, D. Cicchetti and D.J. Cohen, Editors. 1995, Wiley: New York. p. 618-655.
112. White, S.A., *Motivation reconsidered: The concept of competence*. Psychol Rev, 1959. 66: p. 297-333.
113. Baumeister, R.F. and M.R. Leary, *The need to belong: desire for interpersonal attachments as a fundamental human motivation*. Psychol Bull, 1995. 117(3): p. 497-529.
114. Bowlby, J., *The nature of a child's tie to his mother*. Intern J Psychoan, 1958. 99: p. 265-272.
115. Harlow, H.F. and . *The nature of love*. Am Psychol, 1958. 13: p. 673-685.
116. Angyal, A., *Neurosis and treatment: A holistic theory*. 1965, New York: Wiley.
117. DeCharms, R., *Personal causation*. 1968, New York: Academic.
118. Sheldon, K.M. and A.J. Elliot, *Goal striving, need satisfaction, and longitudinal well-being: The Self-Concordance Model*. J Person Soc Psychol, 1999. 76: p. 546-557.
119. Deci, E. and R. Ryan, *Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health*. Can Psychol, 2008. 49(3): p. 182-185.
120. Hull, C.L., *Principles of behavior: An introduction to behavior theory*. 1943, New York: Appleton-Century-Crofts.
121. Hagger, M. and N. Chatzisarantis, *From exercise intention to exercise behavior and beyond*, in *The Social Psychology of Exercise and Sport*, S. Sutton, Editor. 2005, Open University Press: Glasgow.
122. Deci, E.L. and R.M. Ryan, *A motivational approach to self: Integration in personality*, in *Nebraska symposium on motivation*, R. Dienstbie, Editor. 1991, University of Nebraska Press.: Lincoln.

123. Sheldon, K.M., R.M. Ryan, L. Rawsthorne, and B. Ilardi, *Trait self and true self: Cross-role variation in the Big Five traits and its relations with authenticity and subjective well-being*. J Person Soc Psychol, 1997. 73: p. 1380-1393.
124. Nix, G., R.M. Ryan, J.B. Manly, and E.L. Deci, *Revitalization through self-regulation: The effects of autonomous and controlled motivation on happiness and vitality*. J Exp Soc Psychol, 1999. 35: p. 266-284.
125. Ryan, R. and E. Deci, *Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being*. Am Psychol, 2000. 55(1): p. 68-78.
126. Ryan, R. and R. Connell, *Perceived locus of causality and internalization: Examining reasons for acting in two domains*. J Person Soc Psychol, 1989. 57: p. 749-761.
127. Vallerand, R. and L. Pelletier, *Reflections on Self-Determination Theory*. Can Psychol, 2008. Vol. 49(3): p. 257-262.
128. Rodgers, W. and C. Loitz, *How Do We Encourage Our Clients To Be Active? ACSM's Health and Fitness Journal*, 2008. 13(1): p. 7-12.
129. Pelletier, L.G., K.M. Tuson, and N.K. Haddad, *Client motivation for therapy scale: A measure of intrinsic motivation, extrinsic motivation, and amotivation for therapy*. J Person Assessm, 1997. 68: p. 414-435.
130. Williams, G.C., V.M. Grow, Z.R. Freedman, R. Ryan, and E. Deci, *Motivational predictors of weight loss and weight-loss maintenance*. J Person Soc Psychol, 1996. 70(1): p. 115-26.
131. Rose, E., G. Parfitt, and G. Williams, *Exercise causality orientations, behavioral regulation for exercise and stage of change for exercise: exploring their relationships*. Psychol Sport Exerc, 2005. 6: p. 399-414.
132. Wilson, P., D. Mack, and K. Grattan, *Understanding Motivation for Exercise: A Self-Determination Theory Perspective*. Can Psychol, 2008. 49(3): p. 250-256.
133. Edmunds, J., N. Ntoumanis, and J. Duda, *Testing a self determination theory-based teaching style intervention in the exercise Domain*. Eur J Soc Psychol, 2008. 38: p. 375-388.
134. Hagger, M. and N. Chatzisarantis, *Intrinsic motivation and self-determination in exercise and sport*. 2007: Human Kinetics.
135. Edmunds, J., N. Ntoumanis, and J. Duda, *A test of self-determination theory in exercise domain*. J Appl Soc Psychol, 2006. 36: p. 2240-2265.

136. Edmunds, J., N. Ntoumanis, and J. Duda, *Understanding exercise adherence and psychological well-being from a self-determination theory perspective among a cohort of obese patients referred to an exercise on prescription scheme*. *Psychol Sport Exerc*, 2007. 8: p. 722-740.
137. Fortier, M.S., S.N. Sweet, T.L. O'Sullivan, and G. Williams, *A self-determination process model of physical activity adoption in the context of a randomized controlled trial*. *Psychol Sport Exerc*, 2007. 8: p. 741–757.
138. Ryan, R. and E. Deci, *Active human nature: Self-determinant theory and the promotion and maintenance of sport, exercise and health*, in *Intrinsic motivation and self-determination in exercise and sport*, M. Hagger and N. Chatzisarantis, Editors. 2007, Human Kinetics: Champaign, IL.

CHAPTER 3

A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: rationale and intervention description¹

“We suggest that interventions can be regarded as theory-based when the theory used to interpret findings has two characteristics. First, it provides a clear account of hypothesized mechanisms or causal processes that generate behavior change (...). Second, the theory is supported by independent experimental work.”

Michie & Abraham, 2004, p.33

¹ Silva, M. N., Markland, D., Minderico, C. S., Vieira, P. N., Castro, M. M., Coutinho, S. R., Matos, M.G. & Teixeira P.J. (2008). A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: rationale and intervention description. *BMC Public Health*, 8, 234-347.

ABSTRACT

Background: Research on the motivational model proposed by Self-Determination Theory (SDT) provides theoretically sound insights into reasons why people adopt and maintain exercise and other health behaviors, and allows for a meaningful analysis of the motivational processes involved in behavioral self-regulation. Although obesity is notoriously difficult to reverse and its recidivism is high, adopting and maintaining a physically active lifestyle is arguably the most effective strategy to counteract it in the long-term. The purposes of this study are twofold: i) to describe a 3-year randomized controlled trial (RCT) aimed at testing a novel obesity treatment program based on SDT, and ii) to present the rationale behind SDT's utility in facilitating and explaining health behavior change, especially physical activity/exercise, during obesity treatment. **Methods:** Study design, recruitment, inclusion criteria, measurements, and a detailed description of the intervention (general format, goals for the participants, intervention curriculum, and main SDT strategies) are presented. The intervention consists of a 1-year group behavioral program for overweight and moderately obese women, aged 25 to 50 (and pre-menopausal), recruited from the community at large through media advertisement. Participants in the intervention group meet weekly or bi-weekly with a multidisciplinary intervention team (30 sessions in total), and go through a program covering most topics considered critical for successful weight control. These topics and especially their delivery were adapted to comply with SDT and Motivational Interviewing guidelines. Comparison group receive a general health education curriculum. After the program, all subjects are follow-up for a period of 2 years. **Discussion:** Results from this RCT will contribute to a better understanding of how motivational characteristics, particularly those related to physical activity/exercise behavioral self-regulation, influence treatment success, while exploring the utility of Self-Determination Theory for promoting health behavior change in the context of obesity. **Clinical Trials Gov. Identifier** NCT00513084

BACKGROUND

Prevalence of overweight and obesity in modern societies has increased rapidly. Recent reports indicate that 51.6% Portuguese adults are overweight or obese [1]. Obesity is a major public health problem, associated with a number of chronic disease risk factors [2]. Furthermore, overweight and obesity are stigmatizing conditions, especially for women, and are often associated with dysphoric states and psychological problems [3]. Weight loss is recommended as an important part of clinical management and extensive research supports the utility of including physical activity/exercise in weight reduction programs [4]. Unfortunately, the evidence shows that relatively little of the weight loss accomplished in treatment programs is maintained over the long-term [5]. Therefore, there is a strong need for research that identifies predictors of successful weight-loss *maintenance* and tests interventions to specifically promote weight stability after weight loss [6]. Additionally, considering the available evidence regarding behavioral correlates of successful weight loss, comparatively little is known regarding psychological processes associated with long-lasting weight management [7], namely sustained motivation.

The present research project aims at describing a randomized controlled clinical trial (RCT) conceived to test a novel obesity treatment program based on Self-Determination Theory (SDT). Herein, we seek i) to present the theoretical rationale of adopting SDT (and facets of Motivational Interviewing) to facilitate and explain sustained change in physical activity and body weight, and ii) to describe the actual intervention, at a level of detail that effectively allows its evaluation and replication. This is a recommendation from the Behavior Change Consortium [8] and other researchers [9], considering that intervention descriptions are often not specific about the techniques employed and that there is no clear correspondence between theoretical "inspiration" and adoption of particular behavior change techniques. Experimental research and increased theoretical and methodological clarity could accelerate the

identification of effective behavior change techniques and the development of evidence-based-practice in health psychology and education. Unfortunately, few examples are currently available in the published peer-reviewed literature.

Primarily, we will evaluate the extent to which a more internal self-regulatory style, higher intrinsic motivation, and more internal perceived locus of causality (regarding exercise behavior) act as mediators of sustained exercise adherence and weight loss. Motives to exercise are also expected to mediate the impact of the intervention on behavioral outcomes; psychological, interpersonal, and health-related motives are hypothesized to positively predict long-term exercise participation. Secondly, individual differences in general causality orientations will be evaluated as moderators of intervention effects; more successful participants are expected to show a more autonomous (less controlling) general orientation style. A comparison group is included in the research design, to adequately test intervention-specific moderation and mediation hypotheses [10].

Theoretical rationale

Self-Determination Theory and motivation for health behavior

Many recent studies have shown the crucial role that motivated behaviors, such as regular exercise, following a healthy diet, and not smoking, can play in the maintenance of health [11]; many people at health risk have the means readily at hand to improve their condition, assuming that they are willing to act. In fact, the failure of many people to adhere to healthy behaviors represents a public health problem, one with many causes but for which a considerable part is motivational in nature. This highlights the need for a clearer understanding of what motivation is and how to facilitate it in the context of health behavior.

Motivation refers to the psychological forces or energies that impel a person toward a specific goal. However, for many years, motivation was viewed in a one dimensional way, as varying only in amount or quantity. Introducing the issue of *quality* of the motivational drive, Deci and Ryan [12,13] developed the Self-Determination Theory (SDT) which distinguishes between *amotivation* (lacking any intention to engage in a behavior), *extrinsic motivation* (where the behavior is engaged in order to achieve outcomes that are separable from the behavior itself) and *intrinsic motivation* (where the behavior is engaged in for the enjoyment and satisfaction inherent in taking part). In addition, SDT distinguishes between qualitatively different forms of extrinsic motivation, by contrasting *autonomous* or *self-determined* vs. *controlled* or *non self-determined* types of behavioral regulation. This distinction is represented as a continuum and is characterized in terms of the degree to which the regulation of a behavior has been internalized so that it is engaged in with a true sense of volition and choice. Motivation is autonomous to the extent that a person's perceived locus of causality is *internal* (i.e. the perceived source of initiation and regulation for motivated behaviors emanates from the self). Motivation is controlled to the extent that people act because they feel pressured or compelled to do so, either by others or by themselves, and this involves having an *external* perceived locus of causality [14].

According to Deci and Ryan, intrinsic motivation is linked to greater productivity, creativity, spontaneity, cognitive flexibility, and perseverance [12]. However, most human behaviors are not intrinsically motivated, which highlights the importance of studying extrinsic forms of motivation.

Four types of extrinsic motivation have been described, which can be located on a self determination continuum [15]. *External regulation* is at the lower end of the continuum. It means doing something in order to gain a reward or to avoid a punishment administered by others. *Introjected regulation* involves an internal feeling of obligation, a need to act in order

to avoid feelings of guilt (although the pressure stems from inside, the individual does not feel free regarding the behavior). *Identified Regulation* concerns doing something based on the value of its consequences. In this case, the individual feels free to act and does so because the outcomes are personally important. Finally, when a behavior is coherent with the person's other values, personality schemas and sense of self, the regulation is fully self-determined and said to be *integrated*. SDT proposes that human motivation, vitality, development, and psychological adaptation can be explained by the process of *internalization*, that is, movement along this continuum [13]. A model describing internalization and human motivation is presented in Figure 1.

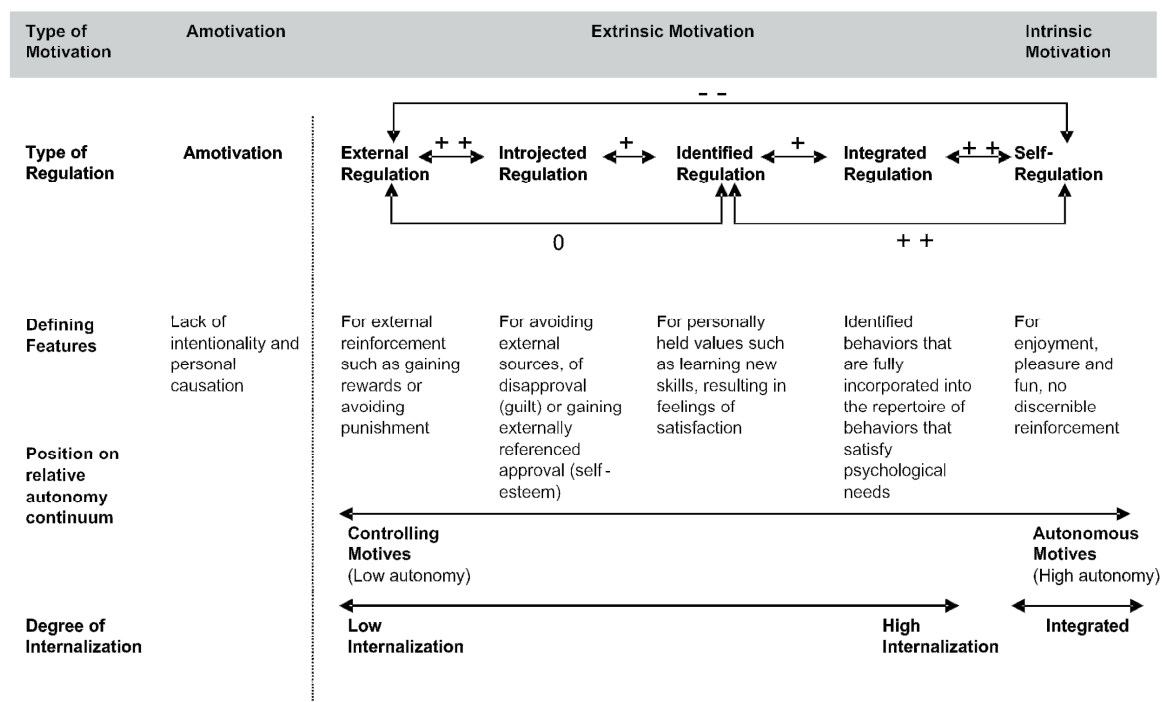


Figure 1: Model Describing Internalization and Human Motivation.

Model shows different types of motivation and regulation *continuum* reflecting varying degrees of internalization and self-determination. This *continuum* reflects a *simplex-ordered* structure, evident when the correlation between scales measuring adjacent types of motivation such as *external* regulation and *introjected* regulation is higher than the correlation between dimensions that lie further apart such as *external* regulation and *identified* regulation. Adapted from [68].

Autonomous behavior is an expression of one's self and is undertaken with a full sense of choice, accompanied by an internal perceived locus of causality and a sense of true volition. Importantly, according to this theory, autonomously motivated behaviors are more likely to result in meaningful, long-lasting changes. Conversely, behaviors that are controlled by rewards and punishments or by self-imposed pressures are predicted to last only as long as the contingencies or pressures remain in place.

Fortunately, according to SDT, formerly controlled motivation can be internalized and transformed into autonomous motivation, if supportive conditions are in place. In fact, this contemporary theory of human motivation focuses on the psychological nutrients that engender adaptive motivational, behavioral, cognitive, and affective outcomes, by specifying contextual variables that facilitate (or hinder) these processes. The way a person acts in a particular setting cannot be attributed only to individual differences; contextual variables also exert a significant influence. Thus, SDT also considers the influence of the social environment on motivation. According to Deci and Ryan [13], although people have an inherent propensity toward maintaining their well-being, this natural tendency can be thwarted by conditions that frustrate the satisfaction of three basic psychological needs. These needs are for *autonomy* (feeling volitional and feeling choice and responsibility for one's behavior), *competence* (feeling that one can accomplish the behaviors and reach the goal) and *relatedness to others* (feeling understood, cared for and valued by significant others). In the context of health, socio-environmental conditions that facilitate the satisfaction of these needs will promote the internalization of protective and preventive health behaviors so that they are engaged in autonomously and more likely to be maintained in the long term. A recent study in the context of exercise adherence clearly indicated that fulfillment of these three basic needs was related to more self-determined motivational regulations [16]. It can generally be stated that people need to feel a sense of choice and volition with respect to their health-related goals; they need

to understand how to attain these goals and feel that they can be effective in carrying out the necessary actions; and feel respected and cared for by practitioners and important others. This means that people not only need to feel that they can carry out a certain behavior (confidence, efficacy, competence), they also need to feel that they are fully responsible for initiating and maintaining that behavior and that they are doing so willingly (autonomy, self-determination, responsibility).

According to SDT, a person will develop and maintain more self-determined motivation when the personal context around them is *autonomy supportive*. The idea of autonomy support refers to eliciting and acknowledging peoples' perspectives, supporting their initiatives, offering choice/options, and providing relevant information, while minimizing pressure and control. Previous research has demonstrated that when physicians are perceived by their patients as being autonomy supportive, patients report greater self-motivation for treatment adherence [17]. Another recent study, designed to test a SDT intervention for motivating tobacco cessation in a clinical trial [18], showed that intervention participants perceived greater autonomy support and reported greater autonomous and competence motivations than did controls, supporting the causal role of autonomy support in the internalization of more internal forms of regulation.

Self-Determination Theory, exercise and weight control

According to SDT's basic tenets, successful maintenance of weight reduction would occur when people chose eating and exercise behaviors because they personally value weight loss maintenance and its health benefits. Lasting behavior change necessary for maintenance depends not on complying with demands for change but rather on accepting the regulation for change as one's own. In other words, it requires internalizing values and regulation of relevant

behaviors and then integrating them with one's sense of self so they become the basis for autonomous regulation.

Accordingly, successful weight loss and long-term maintenance would not be achieved if reasons for it were mostly controlling (e.g., because the doctor insisted or based on a strong desire to be thin, according to social norms). Being autonomous in one's relevant actions, that is, having an internal perceived locus of causality, is the crucial predictor of maintained behavior change [19]. In a study specifically designed to study the effects of motivational factors during a weight control program, results showed that the degree of autonomous motivation predicted not only attendance at weekly meetings and weight loss during the program, but, more importantly, maintenance of weight loss at the 23-month follow up [20]. The role of exercise in weight management has also been analyzed in relation to SDT. In a recent study on psychosocial predictors of weight management, increase in intrinsic motivation for physical activity was the strongest predictor of long-term weight change, even after adjusting for initial weight-loss [21]. The authors stressed the importance of ensuring that individuals take on physical activities that they intrinsically enjoy, feel competent at, and that contribute positively to their sense of autonomy as key factors for greater success in the difficult task of long-lasting weight control.

A common theme emerging from the problem of exercise adherence concerns the role of individual's reasons for exercising (participation motives) in determining long-term adherence to regular physical activity. Markland's study findings [22] support the idea that extrinsic motives such as exercising for weight control or because of a doctor's exercise prescription may be perceived as controlling thereby undermining self-determination and leading to a lack of enjoyment of exercise. On the contrary, intrinsic motives, such as exercising for enjoyment may be perceived as informational, enhancing perceptions of self-determination, suggesting that controlling exercise regulations may lead to a greater number of relapses from exercise

compared with more self-determined types of exercise regulation. Importantly, exercisers in the maintenance stage of change display significantly more self-determined motivation to exercise than those in the preparation and action stages [23]. Also, others have shown that adherence to exercise in individuals participating in fitness classes is higher when intrinsic motives related to enjoyment and feelings of competence were reported, compared to when body related outcomes (conceptualized as extrinsic) are the primary motivation [24]. Another study on perceived autonomy support for exercise concluded that participants who exercised regularly report modest to large changes in relatedness and competence need satisfaction and intrinsic motivation over time, providing theoretically-sound insights into reasons why people persist with exercise behaviors [25].

The mechanisms that promote self-determined motivation for exercise are now under investigation. Overall enjoyment, perceptions of competence, and intrinsic reasons for participation appear to play a central role in the maintenance of physical activity behaviors [23]. In a large scale RCT, increases in enjoyment mediated physical activity in female adolescents involved in a school-based intervention [26]. In fact, while longitudinal studies are required to better understand the processes underlying maintained exercise behavior, previous results support Markland and Hardy's [27] proposition that an individual's motivational focus needs to shift from extrinsic to intrinsic for long lasting results. New models are needed to understand this shift. We argue that understanding the motivational basis of long-term weight management and exercise requires adopting a more general model of motivation than that offered by the behaviorist tradition, which focuses on controlling a person's behavior with rewards and punishments and on the external determinants of behaviors. It also requires adopting a model more general than that offered by the social cognitive tradition, characterized by a higher emphasis on expected outcomes and enhancing patients' sense of confidence or self-efficacy (quantity of motivation) but not focusing on the

quality of motivation, sense of autonomy, and locus of causality [28]. Self-Determination Theory provides such a model.

The Self-Determination Theory model for maintained behavior change

Figure 2 presents the self-determination model of health behavior change and the expected relationships among its key constructs. Central to the model is autonomous self-regulation for behavior change. Autonomy support, both experimentally manipulated and as perceived by patients, and also a participant's general autonomy orientation, are predicted to enhance autonomous self-regulation and perceived competence. Autonomous self-regulation and perceived competence are in turn expected to increase maintained change of the health-risk behaviors [29].

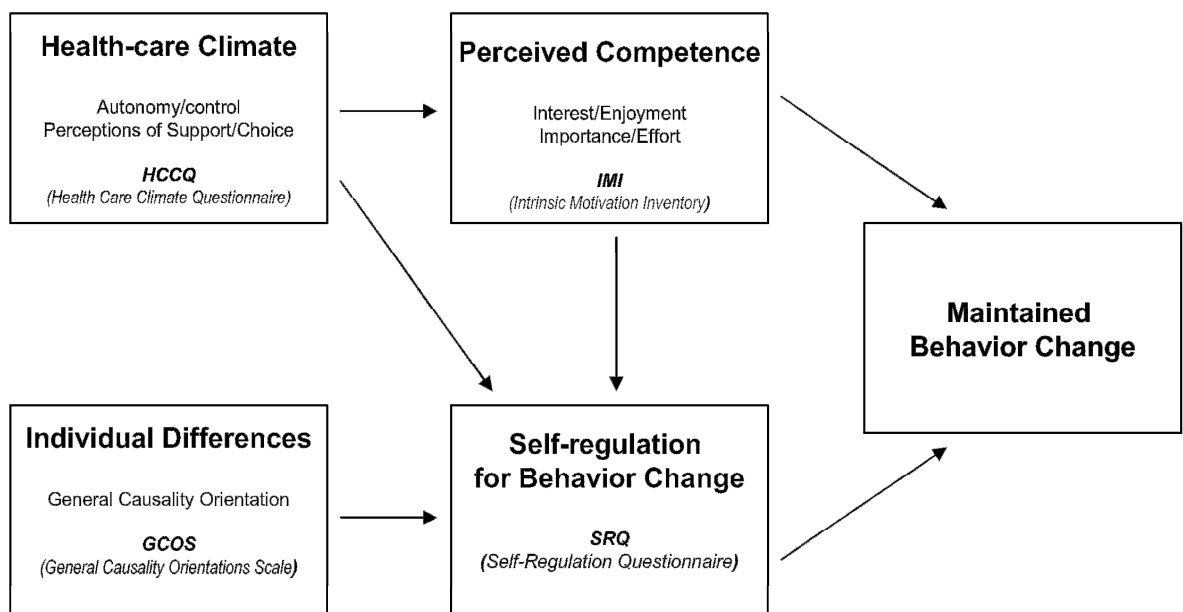


Figure 2: The Self-Determination Theory Model for maintained behavior change.

Model presents key constructs of health behavior change (scales used also) and the expected relationships among them. Autonomy (both as individual orientation and experimentally promoted) is central to maintained behavior change through its effects on competence and self-regulation. See Methods for abbreviations. Adapted from [29].

A recent study [18], aimed at prolonged abstinence from tobacco, was the first to demonstrate that an intervention based on the SDT model facilitates the internalization of motivation, resulting in expected behavioral outcomes. This extends in many ways the previous empirical support for the model found in predicting maintenance of glucose control for diabetes [17], and maintained tobacco abstinence for smokers treated by primary care physicians [30], showing that only when perceived competence is accompanied by the experience of autonomy will it motivate sustained change. The SDT health care model was formulated to account for the promotion of all health-relevant behaviors, including nutrition and physical activity. Edmunds and colleagues demonstrated that the basic tenets advanced by SDT are amenable to manipulation and revealed the potential utility of SDT to shape behavioral interventions targeting the promotion of healthier and more physically active lifestyles [16]. Given the difficult task of long-lasting weight control, an intervention that could significantly increase the percentage of people able to successfully manage their weight in the long-term, through voluntary, stable changes in diet and physical activity, would represent an important contribution.

We selected SDT as the theoretical basis for this study because it is the only empirically-derived theory of motivation which posits that perceived autonomy (or self-determination) is essential for maintained behavior change and because there are validated psychometric instruments for each construct of the theory. Thus we can test an intervention as well as testing a theory-based process model, assuming the need to treat a theory as a dynamic entity whose form and value rests upon being rigorously applied, tested, and refined [31].

METHODS

Study design

Randomized controlled trial, analyzing 3-year change in primary outcomes, consisting of a 1-year behavior change intervention and a 2-year follow-up period with no intervention. Participants (n = 259) entered the study in 3 annual cohorts and each cohort was split into 2 randomly-assigned groups: one intervention group and one comparison group. The intervention group attended about 30 group sessions for approximately one year. The comparison group received a general health education curriculum based on several 3 to 6-week long educational topics (e.g. preventive nutrition, stress management, selfcare and effective communication skills, among others). The Technical University of Lisbon – Faculty of Human Kinetic Ethics Review Board approved the study.

Recruitment

Inclusion criteria

To be included in the study, participants were required to be female, between 25–50 years old, pre-menopausal, have a BMI between 25 and 40 kg/m², be willing to attend weekly meetings (during 1 year) and be tested regularly (during 3 years); be free from major illnesses, not taking (or having taken in the previous year) medication known to interfere with body weight regulation, namely antidepressive medication; and willing to not participate in any other formal or informal weight loss program during the first year of the study (intervention group only). Prior to participation, all participants gave written informed consent.

Participants were recruited through a website, newspapers, TV and radio ads, and with flyers distributed in health care centers, local services, schools, etc., asking candidates to enroll in a group-based behavioral (i.e., no medication involved) weight management program. All women who called to inquire about the study were invited to one of several recruitment

sessions in which the study was described in more detail, including inclusion/exclusion criteria. Of the 943 women who attended recruitment sessions, 462 were excluded because they failed to comply with the inclusion criteria, primarily related to BMI/age limits; 481 met inclusion criteria but only 290 ultimately committed to the study and were contacted to schedule their baseline measurements; 258 completed initial assessments and entered the study.

Intervention

General format

The intervention group met regularly with the intervention team, in groups of 25–30 participants, for the face-to-face phase of the intervention, for approximately one year (30 meetings in all). These meetings were weekly or bimonthly, lasted about 120 minutes, and included educational content where physical activity, nutrition, and behavior change specialists presented participants with information, and also conducted interactive discussion, and small group activities. The intervention team comprised 6 Ph.D. or M.S. level exercise physiologists, nutritionists/ dietitians, and psychologists. Each session had "check in" and "check out" periods. A comprehensive workbook was produced specifically for this study to provide participants with a written companion manual to complement the face-to-face intervention.

Intervention curriculum

Physical activity and exercise

Participants were encouraged to find situations in their lives that could be changed in order to increase their caloric expenditure. This could be done in formal (e.g. health clubs) or informal (e.g. daily transportation) settings. Although most activity was home or community-based and

unsupervised, some sessions included brief periods of physical activity and participants experimented with a variety of individual and group activity classes. All participants were offered a pedometer to monitor their daily steps. Topics on physical activity included: planning and implementing a structured exercise plan to reach caloric expenditure goals; increasing daily walking and lifestyle physical activity (e.g., using the stairs more often); dealing with safety, weather, and equipment issues; overcoming typical barriers to exercise (time, boredom, lack of facilities); how to monitor exercise intensity, among others. One main goal in this area was to encourage participants to find the activities they enjoyed the most and were more likely to retain for the future. Dance classes and a "physical activity challenge program" were developed to prompt fun, enjoyment, reaching new goals, and experimenting with new activities.

Nutrition and eating behavior

The initial emphasis of this program focused on inducing some initial weight loss, which is achieved with a sustained energy deficit, primarily by reducing energy intake. There was also a focus on increasing nutrition knowledge and establishing eating patterns more likely to help subsequent weight maintenance. Specific strategies/goals included: decrease daily caloric intake by 300–400 kcal; improve the overall nutritional quality in the diet; include breakfast and increase the number of meals throughout the day; avoid hunger and uncontrolled intake periods; reduce emotional and "distracted" eating; reduce the amount of food in accordance with energetic demands; prefer low energy density, high-satiety foods; reduce fat in the diet; increase the intake of fruits and vegetables, non-processed cereals and other high fiber foods; reduce the amount of highly processed food and added sugars; consistently read and understand food labels.

Cognitive and behavioral aspects

Addressing motivation and overcoming barriers

This component focused on identifying and addressing problem areas and difficulties related to the cognitive (attitudinal, motivational) and behavioral changes expected to occur during the program. The motivational aspect of the intervention was deemed as particularly important and was designed to identify personal resistances and barriers and provide skills to prevent, recognize, and overcome expected lapses and relapses, cultivate self-motivation, and encourage self-monitoring. To achieve these goals, a special focus was placed on stressing the importance of understanding internal and external/social determinants of one's behavior and increasing self-awareness towards the most significant individual barriers to the adoption of healthier behaviors. Critical areas were emotional eating, exercise motivation, and formulating adequate goals for weight loss. Specific strategies included increasing self-efficacy (e.g., sharing testimonials from successful individuals under similar circumstances, and setting realistic and attainable goals), analyzing and overcoming typical barriers such as lack of time, lack of knowledge and skills, promoting contingency plans for situations likely to affect compliance, seeking regular social support, dealing positively and constructively with lapses, and building a personal rewards system that consistently acknowledged success and the achievement of individual goals.

Increasing knowledge

Before making any changes, participants needed to know why they were necessary and recognize what the purpose of each intervention component was. The goal of this component relied on providing participants with diverse but specific information about issues relevant for weight control and offering women a sound rationale for change. This was conducted in a context that would empower participants and support their sense of competence and autonomy

regarding health choices and behaviors. Two examples are the principles of energy balance, that is, how body fat stores are regulated based on caloric intake and expenditure, and the limits and pitfalls of popular and restrictive diets.

Improving body image

Interventions to improve body image may be helpful adjuncts for people undergoing weight loss, whose concerns extend beyond strictly physical health [32]. Obese persons who start weight reduction programs in pursuit of the ideal physique must confront and come to terms with real limits in their biological and behavioral capacities to meet their goals. Establishing more realistic goals for themselves and their weight/body is an important issue. The main goal in this area was to help participants understand the concept of body image and recognize social and personal threats to their own body image development, stressing that body image is a subjective, psychological construct and that physical appearance and body image can be independent. Persons with negative body image often attribute their life difficulties to their appearance; recovery may be facilitated if participants abandon the idea that they must look different to be happier, attributing negative reactions from others to prejudice rather than to defects in personal traits. Secondly, participants were asked to keep a self-monitoring diary identifying current examples of negative self-statements about physical appearance and negative "body talk", as well as their emotional and behavioral consequences. Third, we worked on cognitive restructuring, helping participants to identify maladaptive assumptions about their appearance, promoting the evaluation of evidence for and against their beliefs and the construction of alternative thoughts. In order to achieve these objectives, relaxation and dance classes were provided to all participants, prompting a more self-conscious and positive relationship between mind and body.

Promoting self-determination

The intervention was designed to establish an autonomy-supportive climate for the participants, regardless of their stage of change or their expectancies and efficacy. The overall goal was to bring each participant closer to making autonomous decisions about whether she wanted to change and how, and then help her cope with the consequences of her choices, whether she succeeded or failed.

The following strategies were used as facilitators in enhancing autonomous motivation [15]:

a) Offering a clear rationale to adopt a specific behavior; presenting clear contingencies between behavior and outcome; building sustainable knowledge that supported informed choices, by using neutral language during interpersonal communication (e.g., "may" and "could", and not "should" or "must"); and acknowledging participants' feelings and perspectives.

b) Acknowledging internal conflict (usual patterns and habits vs. desire to adopt a new behavior); promoting opportunities for participants to indicate their reasons to change activity and nutrition patterns; exploring **perceived benefits and personal barriers**. Such decisional balance constructs have been shown to be important mediators of motivational readiness [33, 34].

c) Providing participants with a menu of options and a variety of avenues for behavior change, supporting the presentation of tasks and choices with a clear rationale. Because different people have different behavioral preferences and barriers, this is expected to lead to greater long-term adherence, allowing each participant higher congruence between their values and goals, and their lifestyles.

d) Promoting competence by practicing skills necessary for completion of specific tasks, such as exercising at a given intensity or reading food labels. More than merely increasing

knowledge, the aim was to promote the adoption of self-management skills such as self-monitoring, goal setting, building contingency plans, and managing time (reallocate time to spend it in ways that are more consistent with personal priorities). The intervention team consistently focused on participants' strengths, affirmed small steps as they were taken, and reinforced positive change, knowing that the feeling of competence grows from feedback inherent to the task (cues for objective success), social feedback (comments from others or comparisons to standards), and progression toward a distal goal.

e) Avoiding the use of external incentives and controlling, non-informational forms of feedback. Rewards, threats, external evaluation, and deadlines have been shown to undermine intrinsic motivation [35]; rewards and feedback that do not support competence and promote an external perceived locus of causality will undermine autonomy and self-regulation.

f) Give positive feedback. Research has shown that feedback as a verbal reward usually enhances intrinsic motivation because it affirms personal competence [15]. This is in accordance with Cognitive Evaluation Theory (a sub-theory of SDT about how social contexts affect motivation), which hypothesizes that perceived competence enhances intrinsic motivation in the context of self-determination. This can be achieved by simply informing people about their performance and avoiding the use of pressuring language, by instructing people how to self-administer informational feedback, and by structuring feedback in a way that does not imply evaluation.

Many of the previous strategies are concordant with **Motivational Interviewing** (MI) [36], a counseling method aimed at promoting behavior change which has successfully been applied to a wide range of health behaviors [37]. Markland, Ryan, Tobin and Rollnick [38] and Vansteenkiste and Sheldon [39] have detailed the parallels between MI and SDT, showing that SDT's theoretical focus on the internalization of therapeutic change and on need

satisfaction is fully compatible with key principles and clinical strategies within MI. MI involves avoiding controlling behaviors such as argumentation and direct persuasion for change. Instead, the approach seeks to empower participants to pursue change by eliciting their own personal reasons for change, expressing empathy, supporting self-efficacy, "rolling with" resistance, and helping them to become more aware of discrepancies between goals and actions. According to Markland et al [38] and Vansteenkiste & Sheldon [39] the construct of *need satisfaction*, as conceptualized within SDT, provides a useful way to understand the positive effects of motivational interviewing. MI's key components [33] may be interpreted in terms of the satisfaction of SDT's three needs by its provision of support for autonomously motivated change, presentation of a clear structure to the behavior change environment, and an engaged and involved relationship with the client so that he or she feels personally understood and accepted (see Figure 3). Thus, MI's practical techniques can help to translate SDT's concept of the facilitation of the process of internalization by need satisfaction into specific therapeutic practices and present new ways of testing and developing SDT.

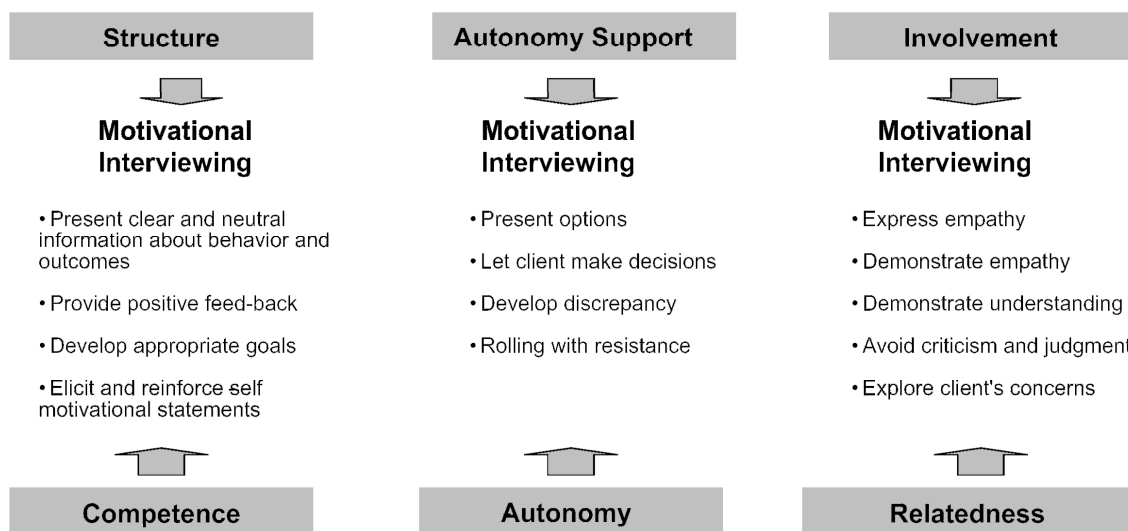


Figure 3: Relations Between Psychological Needs and Motivational Styles From Self-Determination Theory and the Core Principles from Motivational Interviewing.

Parallels between MI main strategies and factors that are considered in SDT to facilitate integration are striking, providing a theoretical framework for understanding how change occurs. The construct of need satisfaction, as conceptualized within SDT, provides a useful way to understand the positive effects of motivational interviewing. Adapted from [38]

Measurements

In this trial, assessments were planned to occur at baseline, 4, 12, 16, 24, and 36 months. Besides physical activity, diet, and physiological and psychosocial variables (all described below), demographic variables including menopausal status, age, education level, job or occupation, and socio-economic status were assessed via self-report.

Weight was measured twice, to the nearest 0.1 kg (average was used) using an electronic scale (SECA, model 770, Hamburg, Germany) and height is also measured twice, to the nearest 0.1 cm (average was used). Body mass index (BMI) in kilograms per squared meter was calculated from weight (kg) and height (m).

Body composition was assessed by dual energy x-ray absorptiometry, DXA (QDR-1500; Hologic, Waltham, MA, USA, software version 5.67). Assessment of anthropometric measurements also included body circumferences, total body, trunk, and abdominal fat mass, total body and appendicular fat-free mass. **Resting metabolic rate** was measured using the MedGem portable device (MedGem®, Health Tech™ Inc., Golden, CO, USA).

Physical activity and exercise was measured objectively with the GT1 accelerometer (Actigraph LLC, Pensacola, FL, USA), which quantifies activity counts for every day of the week and estimates free-living PA and energy expenditure at different intensity levels. Participants also concurrently carried a Yamax Digi-Walker SW-200 pedometer (New Lifestyles, Lee's Summit, MO, USA) for assessment of daily steps. This pedometer is a highly accurate and a reliable step counter and is effective for both walking and running [40,41]. In addition, the 7-day Physical Activity Recall (7-d PAR) was used, in interview format, asking subjects to list all activities of moderate, hard, and very hard intensity, as well as daily walking minutes [42,43]. For this calculation, the time spent in each category (hours) is

multiplied by body weight and a caloric, or MET value (based on intensity) to yield total exercise energy expenditure.

Dietary intake was assessed with three 24-h diet records (randomly assigned days each testing period, including one weekend and two week days). Diet records are analyzed for energy and nutrient intake using Food Processor SQL (Nutrition Analysis Software Version 7.4, ESHA Research, Salem, OR, USA). Participants completed a comprehensive battery of **psychosocial measures** covering several areas considered as relevant to weight management [44]. This was conducted in standardized conditions of comfort and silence, with a study technician attending every assessment period. Psychosocial areas included previous diets and weight history variables taken from a *diet/weight history questionnaire* developed specifically for this study. Weight outcome

evaluations were assessed by 4 questions derived from the *Goals and Relative Weights Questionnaire (GRWQ)* [45], *body size dissatisfaction* was assessed by the difference between self and ideal body figures selected from a list of 9 female silhouettes of increasing size [46]. Body image was further evaluated with the *Body Shape Questionnaire (BSQ)* [47] and the *Physical Self-Perception Profile (PSPP)* [48]. Physical activity determinants were assessed with the *Exercise Perceived Barriers (EPB)*[49], and *Exercise Self-efficacy (ESE)* [50] scales. Dietary restraint, disinhibition and hunger were assessed with the *Three-Factor Eating Inventory* [51]. Psychological states and traits were also considered. Depression status was assessed with the *Beck Depression*

Inventory II (BDI-II) [52] and Anxiety was evaluated with the *State-Trait Anxiety Inventory (STAI)* [53]. Self-esteem was assessed with the *Self-Esteem/Self-Concept Questionnaire* [54]. Quality of Life related to weight was measured with the *Impact of Weight on Quality of Life Questionnaire (IWQOL)* developed by Kolotkin et al. [55]. Health-related quality of life was

assessed with the *Medical Outcome Survey Short-Form (SF-36)* developed by Ware [56]. Social support for exercise was measured with the *Exercise Social Support Scale (ESS)* [57]. The following psychosocial questionnaires related to SDT were also included, in order to test the intervention model (see Figure 1).

Self-Determination Theory related instruments

General causality orientations were assessed with the *General Causality Orientations Scale (GCOS)* [58]. Exercise intrinsic motivation was measured with the *Intrinsic Motivation Inventory (IMI)* [27], adapted to specifically measure the dimensions of exercise interest/enjoyment, perceived competence, effort/importance and pressure/ tension. The *Locus of Causality for Exercise Scale (LCE)* [59] assessed locus of causality for exercise. The *Health Care Climate Questionnaire (HCCQ)* [20] measured participants' perceptions of the degree of autonomy support (vs. controllingness) of the relevant health-care providers. The *Exercise Self-Regulation Questionnaire (SRQ-E)* [60] assessed domain-specific individual differences in types of motivation or regulation (external, introjected, identified, and integrated). Finally, the *Exercise Motives Inventory (EMI-2)* [61,62] assessed exercise participation motives on five dimensions (psychological, interpersonal, health-related, body-related and fitness-related motives), including 14 subscales. At baseline and treatment's end (12 months) individual interviews of approximately 45 minutes were also conducted. The addition of qualitative information to quantitative data (i.e., psychometric instruments) is an important and innovative aspect of this study's assessment plan. Due to space limitations, interviews are not described in detail herein.

Statistical analyses

Analysis will be conducted for completers-only and using an intent-to-treat model. Baseline data imputation for missing scores at follow-up will be employed by default. Despite

limitations of any imputation strategy, this method is conservative and has been recommended before [63]. The use of these models is very important in clinical trials where completion is less than perfect, since completers-only analyses can be severely biased and underpowered [44]. For analysis of moderators and mediators, we will follow recommendations by Kraemer et al. [10]. Generally, for each primary outcome, linear models will be conducted to test for 1) main effect of intervention (I), 2) main effects of each moderator or mediator (M), 3) interactive effects of M and I, 4) overall effect of intervention (plus high vs. low M) and 5) effect of intervention for subgroups of subjects at specific levels of M. A moderator will be defined as a baseline variable (thus uncorrelated with intervention) that interacts with intervention assignment to produce significant effects. The overall effect of intervention ("additive" effect of intervention and M) will represent the actual (clinical) impact of intervention participation in the presence of M. Finally, profiles of subjects with particular values of M may be identified who are responsive to this particular SDT-based intervention. Measures of central tendency and distribution will be examined for body weight and psychosocial variables at the different measurement periods. Repeated measures ANOVA and ANCOVA General Linear Model will be used to assess change in dependent variables and to test for within-and between-group differences. Multiple regression analyses and recursive partitioning (signal detection methodology) [64] will be employed to identify characteristics/profiles associated with success, following the principles enunciated above.

Sample size and power

Sample size calculations were estimated for primary outcomes for a power of 0.8, and a two-tailed $p < 0.05$. At 1 year, for physical activity, we assume an increase of 300 ± 500 METs-min/sem (intervention, mean \pm SD) and 50 ± 400 METs-min/sem for comparison's. A difference effect size (ES) of 0.56 is obtained, for which a sample of 52 participants/group is needed. For changes in body weight (%change of initial) and relative body fat (% change from

initial) estimated ES are large (>0.83) and would require considerably less participants/group. Difference ES for some psychosocial variables were also calculated, with estimates (means and SD) based on our previous work [65], and range from 0.67 to 0.83. At maximum, 36 participants/ group would be needed to detect significant differences in these variables between intervention and controls. Assuming a dropout rate of 20%, 120 participants/group will remain at 1-year (our primary endpoint) enough to detect even small differences in PA. The lowest ES observed (for PA, ~ 0.5) would require ~ 60 participants/ group. In the behavioral sciences, "moderate" and "strong" ES for associations between variables ($R^2 \times 100$ or percent variance accounted) have been set at 5% and 10% respectively, which is equivalent to correlations of 0.22 and 0.31 [66]. Thus, our sample size will be adequate even for the lowest (i.e., "moderate") association levels.

DISCUSSION

Despite the cumulative evidence for the positive role of regular physical activity and exercise in long-term weight management, it remains unclear why only about 20% of individuals seeking weight loss are able to successfully integrate activity behaviors into their lifestyles and achieve long-lasting weight control [6]. Since few data are available concerning exercise motivation in the context of weight control, studies in this domain are critical and we believe further application of SDT in the behavioral treatment of obesity is a potentially fruitful area to explore. On the other hand, although empirical data generally support the efficacy of research using motivational techniques, the underlying mechanisms for change remain largely unexplored. According to Bauman [67], if an intervention is not well implemented, it may not affect the proposed mediators and, as a consequence, outcomes may not be sufficiently improved. According to previous research [18,20,30], SDT should be useful in explaining the dynamics of motivation during the course of obesity treatment, providing direct empirical support for autonomy, competence, and perceived autonomy support as three of the

psychological processes through which intensive behavioral treatment might operate. Key innovative features of this study are: a theory-based intervention based on the principles of Self-Determination Theory, a unique setting and population (the first long-term RCT for weight loss conducted in Portugal), *a priori* selection of putative moderators and mediators responsible for therapeutic change, high emphasis on physical activity/exercise, both as exposure and outcome, a systematic evaluation of a large range of potential determinants of outcomes, objective measurements of physical activity (via accelerometry), and precise measure of body composition changes (via DXA). Results from this study are expected to contribute to a better understanding of how motivational characteristics, particularly those related to physical activity/exercise, influence treatment success during obesity treatment, while exploring the utility of Self-Determination Theory for promoting health behavior change in this most important context. That theory should evolve based on rigorous empirical evidence and that applied intervention research is one of the best ways to evaluate and refine theory [31].

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

MNS and PJT conceived this study and drafted the manuscript. MNS led the design and implementation of the behavioral component of the intervention. LBS and PJT are principal investigators and defined the RCT's design, assessments, and analyses. CSM, PNV, MC, TCS, SSC actively participated in the intervention and in data collection. DM and MM provided critical review of the manuscript. All authors read and approved the final manuscript.

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REFERENCES

1. Carmo I, Dos Santos O, Camolas J, Vieira J, Carreira M, Medina L, Reis L, Galvao-Teles A: **Prevalence of obesity in Portugal.** *Obes Rev* 2006, **7**:233-237.
2. Wadden TA, Brownell KD, Foster GD: **Obesity: responding to the global epidemic.** *J Consult Clin Psychol* 2002, **70**:510-525.
3. Byrne SM, Cooper Z, Fairburn CG: **Psychological predictors of weight regain in obesity.** *Behav Res Ther* 2004, **42**:1341-1356.
4. ACSM: **American College of Sports Medicine Position Stand: appropriate intervention strategies for weight loss and prevention of weight regain for adults.** *Med Sci Sports Exerc* 2001, **33**(12):2145-2156.
5. Stevens J, Truesdale KP, McClain JE, Cai J: **The definition of weight maintenance.** *Int J Obes (Lond)* 2006, **30**:391-399.
6. Wing R, Hill J: **Successful Weight Loss Maintenance.** *Anl Rev Nut* 2001, **21**:323-341.
7. Elfhag K, Rössner: **Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain.** *Obes Rev* 2005, **6**:67-85.
8. Ory M, Jordan P, Bazzarre T: **The Behavior Change Consortium: setting the stage for a new century of health behaviorchange research.** *Health Ed Res* 2002, **17**:500-511.
9. Michie S, Abraham C: **Interventions to change health behaviours: evidence-based or evidence-inspired?** *Psychol and Health* 2004, **19**:29-49.
10. Kraemer HC, Wilson GT, Fairburn CG, Agras WS: **Mediators and moderators of treatment effects in randomized clinical trials.** *Arch Gen Psychiatry* 2002, **59**:877-883.

11. Sheldon G, Williams G, Joiner T: **Self-determination theory in the clinic: motivating physical and mental health.** New Haven, Yale University Press; 2003.
12. Deci E, Ryan R: **Intrinsic motivation and self-determination in human behavior.** New York:, Plenum; 1985.
13. Ryan RM, Deci EL: **Self-determination theory and the facilitation of intrinsic motivation, social development, and wellbeing.** *Am Psychol* 2000, **55**:68-78.
14. Chirkov V, Ryan RM, Kim Y, Kaplan U: **Differentiating autonomy from individualism and independence: a self-determination theory perspective on internalization of cultural orientations and well-being.** *J Pers Soc Psychol* 2003, **84**:97-110.
15. Deci EL, Eghrari H, Patrick BC, Leone DR: **Facilitating internalization: the self determination theory perspective.** *J Pers* 1994, **62**:119-142.
16. Edmunds J, Ntoumanis N, Duda J: **Self Determination Theory in the Exercise Domain.** *J Appl Soc Psychol* in press.
17. Williams GC, McGregor HA, Zeldman A, Freedman ZR, Deci EL: **Testing a self determination theory process model for promoting glycemic control through diabetes self-management.** *Health Psychol* 2004, **23**:58-66.
18. Williams GC, McGregor HA, Sharp D, Levesque C, Kouides RW, Ryan RM, Deci EL: **Testing a self-determination theory intervention for motivating tobacco cessation: supporting autonomy and competence in a clinical trial.** *Health Psychol* 2006, **25**:91-101.
19. Rose E, Parfitt G, G. W: **Exercise causality orientations, behavioural regulation for exercise and stage of change for exercise: exploring their relationships.** *Psychol Sport Exerc* 2005, **6**:399-414.
20. Williams GC, Grow VM, Freedman ZR, Ryan RM, Deci EL: **Motivational predictors of weight loss and weight-loss maintenance.** *J Pers Soc Psychol* 1996, **70**:115-126.
21. Teixeira PJ, Going SB, Houtkooper LB, Cussler EC, Metcalfe LL, Blew RM, Sardinha LB, Lohman TG: **Exercise motivation, eating, and body image variables as predictors of weight control.** *Med Sci Sports Exerc* 2006, **38**:179-188.
22. Markland D: **Internally informational versus internally controlling exercise motives and exercise enjoyment: The mediating role of self-determination.** In *Sport Science*

'99 in Europe. *Proceedings of the 4th Annual Congress of the European College of Sport Science* Edited by: P. P, F. P and G. P. Rome, University Institute of Motor Sciences; 1999.

23. Thogersen-Ntoumani C, Ntoumanis N: **The role of self-determined motivation in the understanding of exercise-related behaviours, cognitions and physical self-evaluations.** *J Sports Sci* 2006, **24**:393-404.
24. Ryan R, Frederick C, Lepes D, Rubio N, Sheldon K: **Intrinsic Motivation and Exercise Adherence.** *International Journal of Psychology* 1997, **28**:335-354.
25. Wilson P, Rodgers W: **The relationship between perceived autonomy support exercise regulations and behavioural intentions in women.** *Psychology of Sport and Exercise* 2003, **5**:229-242.
26. Dishman RK, Motl RW, Saunders R, Felton G, Ward DS, Dowda M, Pate RR: **Enjoyment mediates effects of a school-based physical- activity intervention.** *Med Sci Sports Exerc* 2005, **37**:478-487.
27. Markland D, Hardy L: **On the factorial and construct validity of the Intrinsic Motivation Inventory: conceptual and operational concerns.** *Res Q Exerc Sport* 1997, **68**:20-32.
28. Bandura A: **Self-efficacy: toward a unifying theory of behavioural change.** *Psychol Rev* 1977:191-215.
29. Williams GC, Minicucci DS, Kouides RW, Levesque CS, Chirkov VI, Ryan RM, Deci EL: **Self-determination, smoking, diet and health.** *Health Educ Res* 2002, **17**:512-521.
30. Williams GC, Gagne M, Ryan RM, Deci EL: **Facilitating autonomous motivation for smoking cessation.** *Health Psychol* 2002, **21**:40-50.
31. Rothman AJ: **"Is there nothing more practical than a good theory?": Why innovations and advances in health behaviour change will arise if interventions are used to test and refine theory.** *Int J Behav Nutr Phys Act* 2004, **1**:11.
32. Brownell KW T. T .: **The heterogeneity of obesity: Fitting treatments to individuals.** *Behav Ther* 1991, **22**:153-177.
33. Rollnick S, Miller W: **What is Motivational Interviewing?** *Behav Cogn Psychot* 1995, **23**:325-334.

34. Miller W: **Enhancing motivation for change in substance abuse treatment.** Rockville, MD: U.S., Department of Health and Human Services, Center for substance Abuse Treatment; 1999.
35. Simoneau H, Bergeron J: **Factors affecting motivation during the first six weeks of treatment.** *Addict Behav* 2003, **28**:1219-1241.
36. Miller WR: **Motivational interviewing: research, practice, and puzzles.** *Addict Behav* 1996, **21**:835-842.
37. Resnicow K, DiIorio C, Soet J, Borrelli B, Hecht J, Ernst D: **Motivational interviewing in health promotion. It sounds like something is changing.** *Health Psychol* 2002, **21**:444-451.
38. Markland D, Ryan R, Tobin V, Rollnick S: **Motivational Interviewing and self-Determination Theory.** *J Soc Clin Psychol* 2005, **24**:811-831.
39. Vansteenkiste M, Sheldon KM: **There's nothing more practical than a good theory: integrating motivational interviewing and self-determination theory.** *Br J Clin Psychol* 2006, **45**:63-82.
40. Schneider PL, Crouter SE, Bassett DR: **Pedometer measures of free-living physical activity: comparison of 13 models.** *Med Sci Sports Exerc* 2004, **36**:331-335.
41. Le Masurier GC, Tudor-Locke C: **Comparison of pedometer and accelerometer accuracy under controlled conditions.** *Med Sci Sports Exerc* 2003, **35**:867-871.
42. Blair S, Applegate W, Dunn A, Ettinger W, Haskell W, King A, Morgan T, Shih J, Simons-Morton D: **Activity Counseling Trial (ACT): Rationale, design, and methods.** *Med Sci Sports Exerc* 1998, **30**:1097-1106.
43. Dunn A, Marcus B, Kampert J, Garcia M, Kohl H, Blair S: **Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness.** *J Am Med Assoc* 1999, **281**:327-334.
44. Teixeira PJ, Going SB, Sardinha LB, Lohman TG: **A review of psychosocial pre-treatment predictors of weight control.** *Obes Rev* 2005, **6**:43-65.
45. Foster GD, Wadden TA, Vogt RA, Brewer G: **What is a reasonable weight loss? Patients' expectations and evaluations of obesity treatment outcomes.** *J Consult Clin Psychol* 1997, **65**:79-85.

46. Williamson D, Gleaves D, Watkins P, Schlundt D: **Validation of a self-ideal body size discrepancy as a measure of body size dissatisfaction.** *J Psychol Behav Assess* 1993, **15**:57-68.
47. Cooper P, Taylor M, Cooper Z, Fairburn F: **The development and validation of a body shape questionnaire.** *Inter J Eat Dis* 1987, **6**:485-494.
48. Fox K, Corbin C: **The Physical Self Perception Profile: development and preliminary validation.** *J Sports Exerc Psychol* 1989, **11**:408-430.
49. Steinhardt MA, Dishman RK: **Reliability and validity of expected outcomes and barriers for habitual physical activity.** *J Occup Med* 1989, **31**:536-546.
50. Sallis J, Pinski M, Grossman R, Patterson T, Nader P: **The development of self-efficacy scales for health-related diet and exercise behaviours.** *Health Ed Res* 1988, **3**
51. Stunkard A, Messick S: **The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger.** *J Psychos Res* 1985, **Vol. 29**:71-83.
52. Beck AT, Steer RA, Ball R, Ranieri W: **Comparison of Beck Depression Inventories - IA and -II in psychiatric outpatients.** *J Pers Assess* 1996, **67**:588-597.
53. Spielberger CD, Vagg PR: **Psychometric properties of the STAI: a reply to Ramanaiah, Franzen, and Schill.** *J Pers Assess* 1984, **48**:95-97.
54. Rosenberg M: **Society and the adolescent self-image.** Princenton, NJ, Princenton University Press; 1965.
55. Kolotkin RL, Crosby RD, Kosloski KD, Williams GR: **Development of a brief measure to assess quality of life in obesity.** *Obes Res* 2001, **9**:102-111.
56. Ware J, Gandek B: **Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project.** *J Clin Epidemiol* 1998, **51(11)**:903-912.
57. Sallis J, Grossman R, Pinski R, Patterson T, Nadder P: **The development of scales to measure social support for diet and exercise behaviors.** *Prev Med* 1988, **16**:825-836.
58. Deci E, Ryan R: **The General Causality Orientations Scale: Self-determination in personality.** *Journal of Research in Personality* 1985, **19**:109-134.
59. Deci EL, Ryan RM: **A motivational approach to self: integration in personality.** *Nebr Symp Motiv* 1990, **38**:237-288.

60. Ryan R, Connell J: **Perceived locus of causality and internalization: Examining reasons for acting in two domains.** *J Pers Soc Psychol* 1989, **57**:749-761.
61. Markland D, Ingledew D: **The measurement of Exercise Motives: factorial validity and Invariance across gender of a revised Exercise Motivation Inventory.** *Brit J Health Psychol* 1997, **2**:361-376.
62. Ingledew D, Markland D, Medley A: **Exercise motives and states of change.** *J Health Psychol* 1998, **3**:477-489.
63. Ware JH: **Interpreting incomplete data in studies of diet and weight loss.** *N Engl J Med* 2003, **348**:2136-2137.
64. Kiernan M, Kraemer HC, Winkleby MA, King AC, Taylor CB: **Do logistic regression and signal detection identify different subgroups at risk? Implications for the design of tailored interventions.** *Psychol Methods* 2001, **6**:35-48.
65. Teixeira PJ, Going SB, Houtkooper LB, Cussler EC, Martin CJ, Metcalfe LL, Finkenthal NR, Blew RM, Sardinha LB, Lohman TG: **Weight loss readiness in middle-aged women: psychosocial predictors of success for behavioral weight reduction.** *J Behav Med* 2002, **25**:499-5
66. Ryan R M, Plant R W, O'Malley S: **Initial motivations for alcohol treatment: relations with patient characteristics, treatment involvement and dropout.** *Addict Behav* 1995, **20(3)**:279-297.
67. Bauman AE, Sallis JF, Dzewaltowski DA, Owen N: **Toward a better understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders.** *Am J Prev Med* 2002, **23**:5-14.
68. Hagger M, Chatzisarantis N: **From exercise intention to exercise behaviour and beyond.** In *Social Psychology of Exercise and Sport* Edited by: Hagger M and Chatzisarantis NL. Berkshire, England, Open University Press; 20

CHAPTER 4

Using self-determination theory to promote physical activity and weight control: A randomized controlled trial in women²

“Does it work?” and “How well does it work?”

“Behavior change interventions are effective to the extent that they make a difference in terms of appropriately measured behavioral outcomes in properly controlled experiments or trials. The effect size generated by a successful trial indicates the impact that the intervention is likely to have”

Michie & Abraham, 2004, pp. 31-32

² Silva, M. N., Vieira, P. N., Coutinho, S. R., Matos, M. G., Sardinha, L. B., & Teixeira, P. J. (2010). Using self-determination theory to promote physical activity and weight control: A randomized controlled trial in women. *Journal of Behavioural Medicine*, 33 (2): 110-122.

ABSTRACT

Behavior change interventions are effective to the extent that they affect appropriately-measured outcomes, especially in experimental controlled trials. The primary goal of this study was to analyze the impact of a 1-year weight management intervention based on self-determination theory (SDT) on theory-based psychosocial mediators, physic activity/exercise, and body weight and composition. Participants were 239 women (37.6 ± 7.1 years; 31.5 ± 4.1 kg/m²) who received either an intervention focused on promoting autonomous forms of exercise regulation and intrinsic motivation, or a general health education program (controls). At 12 months, the intervention group showed increased weight loss (-7.29 %,) and higher levels of physical activity/exercise ($+138 \pm 26$ min/day of moderate plus vigorous exercise; $+2.049 \pm 571$ steps/day), compared to controls ($P < 0.001$). Main intervention targets such as more autonomous self-regulation (for treatment and for exercise) and a more autonomous perceived treatment climate revealed large effect sizes (between 0.80 and 0.96), favoring intervention ($P < 0.001$). Results suggest that interventions grounded in SDT can be successfully implemented in the context of weight management, enhancing the internalization of more autonomous forms of behavioral regulation, and facilitating exercise adherence, while producing clinically-significant weight reduction, when compared to a control condition. Findings are fully consistent with previous studies conducted within this theoretical framework in other areas of health behavior change.

Keywords: Theory-based intervention, Randomized controlled trial, Weight management, Autonomy promotion, Self-regulation, Intrinsic motivation

INTRODUCTION

Physical activity and exercise have been positively associated with successful long-term weight control in cross-sectional, longitudinal, and retrospective studies (Catenacci and Wyatt 2007), and several major organizations have recommended the addition of 60–90 min per day of moderate intensity PA to a dietary intervention to substantially increase the odds of successful long-term weight loss (Saris et al. 2003; Donnelly et al. 2009). Unfortunately, evidence suggests that more than 70% of US adults fail to meet current PA recommendations (Spiegel and Alving 2005). In Europe, the Eurobarometer (Rutten and Abu-Omar 2004) indicates that although the amount of PA is low, a wide disparity exists (e.g., Northern European countries showing higher levels of physical activity than southern countries) with Portugal reporting the highest percentage (87.8%) of sedentary lifestyles (Varo et al. 2003) and the lowest prevalence (40.7%) of any PA during leisure time (Martinez-Gonzalez et al. 2001). In the context of long-term weight management, it remains unclear why only about 20% of individuals seeking weight loss are able to successfully integrate PA behaviors into their lifestyles and achieve long-lasting weight control (Wing and Hill 2001). These numbers raise the central, but largely unanswered, issue of how to optimally facilitate the adoption of a physically active lifestyle among those overweight and obese, and particularly how to assist them in maintaining PA levels over the long-term.

Although there are other determinants, a special focus should be given to understanding the motivational dynamics of exercise initiation and persistence. As many studies have shown (e.g., Wilson and Rodgers 2003; Rose et al. 2005; Thogersen-Ntoumani and Ntoumanis 2006) enjoyment, competence, intrinsic motivation, and autonomous regulation are reliably associated with exercise participation. This may also hold true for the role of exercemotivation in weight management. In two studies of psychosocial predictors of weight management, increases in intrinsic motivation for PA were among the strongest predictors of long-term

weight change, even after adjusting for initial weight loss (Teixeira et al. 2006, 2009). These and other results (Ryan et al. 1997; Wilson et al. 2004; Mata et al. 2009), support the proposition that an individual's motivational focus needs to shift from extrinsic to intrinsic for long-lasting positive behavioral outcomes (Markland and Hardy 1997).

One theoretical perspective that appears useful for understanding motivation and adherence to exercise, as well as to other health behaviors, is self-determination theory (SDT; Deci and Ryan 1985, 2008; Ryan and Deci 2000). Basic tenets of this theory are that human motivation varies in the extent to which it is autonomous (self-determined) or controlled, and that promoting long-term behavior change implies an understanding of the internalization process, which refers to the inherent tendency, possessed by all humans, to integrate the regulation of extrinsically motivated activities. Thus, SDT accounts for the quality of motivation regulating behavior which lies on a continuum from the lower to the higher autonomously self-determination forms: the least autonomous form of motivation is labeled external regulation, and occurs when a person performs activities either to obtain rewards, or to avoid punishment or sanctions; introjected regulation involves internalizing the behavior's regulation, but not fully accepting it as one's own (behaviors are performed to avoid negative emotions as anxiety and guilt, supporting conditional self-worth); identified regulation reflects participation in an activity because one holds outcomes of the behavior to be personally significant and important (although one may not enjoy the activity itself) and intrinsic, a highly autonomous form of motivation, is present when an activity is engaged because of its inherent satisfaction such as for the fun, interest, or the challenge it offers.

In addition to accounting for the quality of motivation, SDT also addresses the processes that facilitate the motivational development by specifying that more controlled regulations can be internalized and transformed into autonomous motivation, if supportive conditions are in place, i.e., a context that fosters the satisfaction of basic needs for autonomy, relatedness, and

competence (Ryan and Deci 2000). When these needs are met, more self-determined forms of motivational regulation guiding behavior and adaptive behavioral (e.g., exercise engagement), cognitive (e.g., commitment) and well-being (e.g. joy) outcomes are postulated to ensue.

Research utilizing SDT has shown that the degree of autonomous motivation is associated with improved attendance, greater reductions in BMI, and improved maintenance at the 23-month follow-up within a weight loss program (Williams et al. 1996), and also with several other health outcomes such as long-term medication adherence (Williams et al. 1998), improved glycemic control and dietary self-care in diabetes patients (Williams et al. 1998), and maintained smoking cessation in adults (Williams et al. 2002). These and other studies (Rose et al. 2005) clearly indicate that being autonomous in one's relevant actions, that is, having an internal perceived locus of causality, is a crucial predictor of maintained behavior change. This also holds true in the context of exercise, where research has shown that more autonomous regulatory motives are conducive to higher long-term PA adherence (Fortier et al. 2007).

Importantly, not only autonomous motivation has been predictive of change in several health conditions, but it is also modifiable from an intervention standpoint. Recent studies confirmed the effectiveness of manipulating the social-contextual variables proposed by SDT in the context of smoking cessation (Williams et al. 2006) and PA promotion in several contexts, such as sports centers (Edmunds et al. 2008), in school (Wilson et al. 2005; Chatzisarantis and Hagger 2009) and in health care services (Fortier et al. 2007).

Applied intervention research is one of the best ways to evaluate and refine theory and experimental testing of behavior change interventions needs to answer three questions (Michie and Abraham 2004): first, does it work? Demonstrating that an intervention produces measurable improvement relative to an appropriate control group is a pre-requisite to

investment in subsequent trials or adoption in health care practice. Second, how well does it work? The effect size generated by a successful trial indicates the impact that the intervention is likely to have at an individual or population level. Third, how does it work? It requires an understanding of the causal processes and mechanisms, that is, the underlying psychological changes that account for observed behavior change. Well-designed randomized controlled trials (RCT) can help understand what types of interventions promote change in a particular behavior. Despite evidence regarding the promotion of an autonomy supportive climate, with positive consequences, in several domains, no previous RCT has tested an intervention specifically aimed at increasing patients' perceptions of autonomy support, autonomous self-regulation, and intrinsic motivation for physical activity, in the context of behavioral weight management.

The goal of this study was to analyze the 1-year impact of a SDT-based intervention on several self-regulatory variables (regarding treatment and exercise) and on primary outcomes of this trial, namely PA/exercise, weight, and body composition, in previously overweight/obese premenopausal women. At 12 months, we hypothesized that (1) participants in the experimental condition, compared to controls, would report greater perceived autonomy support, more autonomous self-regulation (for treatment and for exercise), higher exercise intrinsic motivation and perceived competence, more internal locus of causality and more autonomous motives for exercise, as well as higher exercise levels, and increased weight loss (primarily due to fat mass); and (2) the intervention program would produce its effects increasingly with time, i.e., compared to the control group, the intervention program would progressively increase the process of internalization of self-regulation for exercise and promote more weight loss along time, during the first year, considering intermediate (4-month) and intervention's end (12-month) results.

METHODS

The study protocol, intervention curriculum, and behavior change strategies are described in more details elsewhere (Silva et al. 2008) and will only be briefly summarized here.

Study design

Randomized controlled trial, consisting of a 1-year behavior change intervention and a 2-year follow-up period with no intervention. Participants entered the study in three annual cohorts and each cohort was split into two randomly-assigned groups, using the random number generator function for Microsoft Excel 2007 for Windows. Experimental groups received an equivalent amount of face-to-face contact with treatment providers (29 sessions in the control group, 30 sessions in the intervention group). The 29 sessions in the control group were delivered grouped into “thematic courses” such as healthy/preventive nutrition, stress management, self-care, and effective communication skills. The interpersonal climate promoted in this condition was similar to that commonly observed in standard health care settings: choices, rationale, and explanations were limited; specific behavioral goals were not set; minimal feedback was provided (Sheldon et al. 2003).

Participants

Participants were recruited through newspaper, flyers, and TV advertisements to enroll in a university-based behavioral weight loss program. To be included in the study they were required to be female, between 25 and 50 years old, premenopausal, not pregnant, have a BMI between 25 and 40 kg/m², be willing to attend weekly meetings (during 1 year) and be tested regularly (during 3 years), be free from major illnesses and not taking (or having taken in the previous year) medication known to interfere with body weight regulation, namely anti-depressive medication, and willing to not participate in any other formal or informal weight

loss program during the first year of the study (intervention group only). Participants' flow in the study is shown in Fig. 1. Prior to participation, all participants gave written informed consent. The Faculty of Human Kinetics Ethics Committee approved the study.

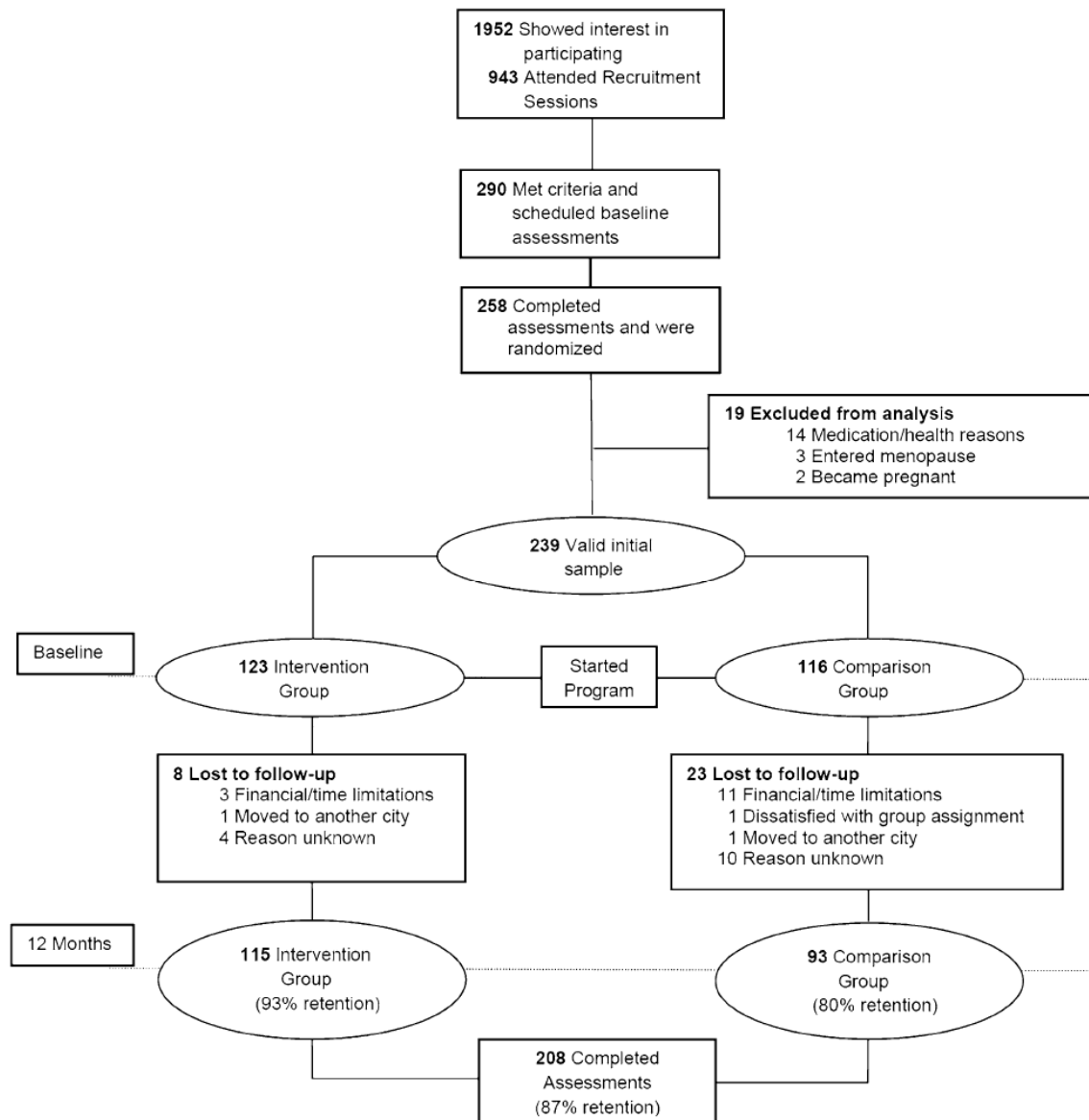


Figure 1: CONSORT diagram

Intervention

The 30 intervention sessions, designed to follow SDT basic tenets, covering PA, eating/nutrition, body image, and other cognitive and behavioral contents, occurred weekly or bi-monthly and lasted about 120 min each. To create an autonomy-supportive environment, the intervention team attempted to promote in each participant a sense of ownership over their behavior such that it would stem from an internal perceived locus of causality. This involved (1) building sustainable knowledge that supported informed choices, by using neutral language during interpersonal communication (e.g., “may” and “could”, and not “should” or “must”); (2) encouraging choice and self-initiation; the use of prescriptions, pressure, demands, and extrinsic rewards were minimal if not absent; (3) providing participants with a menu of options and a variety of avenues for behavior change; (4) supporting the presentation of tasks and choices with a clear rationale to adopt a specific behavior by presenting clear contingencies between behavior and outcome; (5) encouraging participants to build and explore congruence between their values and goals, and their lifestyles and (6) giving informational positive feedback, acknowledging that the feeling of competence grows from feedback inherent to the task (cues for objective success). Further details on these strategies and their theoretical background are available elsewhere (Silva et al. 2008).

Regarding structure, the intervention implementation was generally developed in “modules” which were introduced sequentially but with substantial overlap (see Fig. 2).

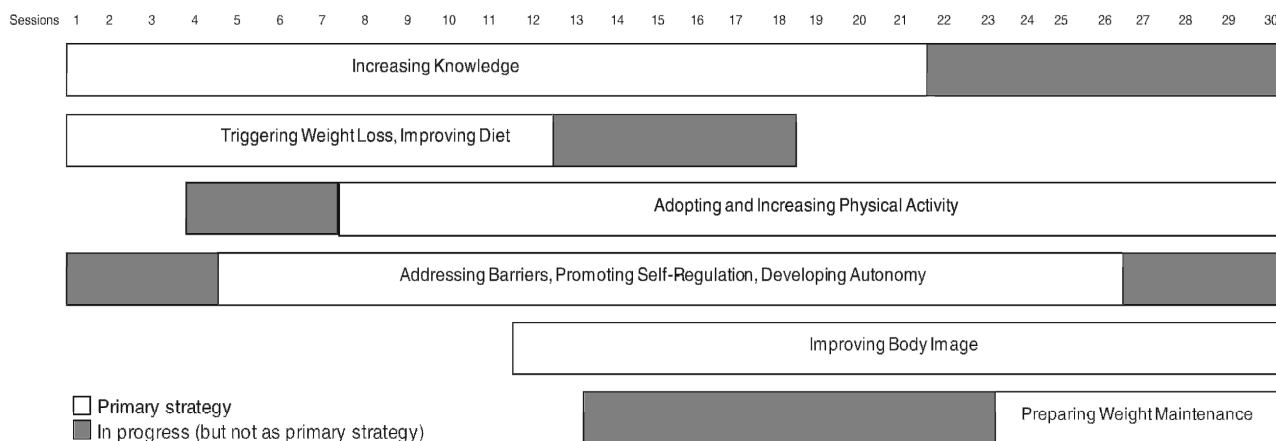


Figure 2 Intervention modules implementation.

Note: This representation was inspired by a similar graph by Cooper and Fairburn (2001)

The initial emphasis of the program focused on triggering weight loss, which was achieved primarily by reducing energy intake. Accordingly, Modules I (increasing knowledge) and II (triggering weight loss, improving diet) were focused on understanding energy balance and principles of gaining/losing weight, nutrition education, and establishing eating patterns more likely to help weight loss. Module III (adopting and increasing physical activity) was introduced by about week 10 and aimed at establishing a more active lifestyle. First we addressed issues related to safety and skills, setting and managing PA goals, monitoring PA, and dealing with barriers to practice, in order to promote feelings of competence. Furthermore, our approach was to provide options and let people make their own decisions, encouraging participants to find the activities they enjoyed the most and were thus most likely to retain for the future. Dance classes and an activity challenge program were also developed to prompt fun, enjoyment, reaching new goals, and experimenting new activities. Module IV (addressing barriers, promoting self-regulation, developing autonomy) focused on identifying and addressing problem areas and difficulties related to the psychological (attitudinal, motivational) and behavioral changes expected to occur during the program. Critical areas

addressed were emotional eating, exercise intrinsic motivation, and adequate goals for weight loss. In Module VI (improving body image), participants' concerns about their body shape were systematically addressed, with the goal of promoting greater self-acceptance and establishing more realistic goals for one's weight/body. Finally, aiming at long-lasting behavior change, the main emphasis of Module VI (preparing weight maintenance) was on helping patients acquire the strategies and skills needed for long-term weight control, such as regular monitoring of weight, adoption of flexible guidelines regarding eating instead of rigid dietary rules, and especially establishing a more physically active lifestyle both through formal and informal exercise.

Measurements

Assessments included lab-measured body weight and body composition (assessed at baseline, 4 and 12 months (end of the intervention program)), self-reported physical activity (assessed at baseline, and 12 months), and general (assessed at baseline and 12 months) and exercise (assessed at 4 and 12 months) SDT-relevant psychological variables. Preliminary validations of the selected SDT psychometric battery proved to be valid, internally consistent, and reliable (M. N. Silva, unpublished data). Internal consistency of all scales is shown in Table 2.

Weight and body composition

All weight-related measurements were performed in the morning, after fasting for 3 h. Body weight was measured twice, using an electronic scale calibrated onsite and accurate to 0.1 kg (SECA, Hamburg, Germany). Vertex height was measured with a balance-mounted/stadiometer to the nearest 0.1 cm. Body mass index (BMI) in kilograms per squared meter was calculated from weight (kg) and height (m). Regional and whole-body composition was evaluated using a Hologic/pencil-beam system (QDR-1500, Waltman, MA, USA).

Images were analyzed with Hologic software 5.63 and all scans were conducted and analyzed by the same technician.

Self-determination theory-based instruments

Intervention-related

The health care climate questionnaire (HCCQ) (Williams et al. 1996) assessed participants' perceived need support, measuring perceptions of the degree to which their team of care providers was autonomy supportive versus controlling. This scale includes items reflecting autonomy support (e.g., "I feel that the staff has provided me choices and options"), involvement (e.g., "The staff handles peoples' emotions very well"), and structure (e.g., "the staff has made sure I really understand my condition and what I need to do"), three dimensions considered essential for an optimally supportive health-care context. Answers to the 15 items were rated on a 7-points Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. A total score was calculated (range 15–105).

The treatment self-regulation questionnaire (TSRQ; Ryan and Connell 1989; Williams et al. 2002) assessed autonomous and controlled reasons for participation in the program. The TSRQ has 18 item stems such as: "I am staying in the weight-loss program because...", followed by several reasons that vary in the extent to which they represent autonomous regulation. Examples of more controlled reasons are: "I want others to see that I am really trying to lose weight" and "I'll feel like a failure if I don't". Examples of more autonomous reasons are: "It's important to me personally to succeed in losing weight" and "I believe it's the best way to help myself." Each reason was rated on a 7-point scale ranging from not true at all to very true. Typically, the responses on the autonomous items are summed to form the autonomous regulation score (range 5–35) for the target behavior while responses on the

controlled items are summed to form the controlled regulation score (range 8–56). These two subscale scores are used separately.

The self-determination scale (SDS; Sheldon et al. 1996) assessed individual differences in the extent to which participants tend to function in a self-determined way. It is thus considered a relatively enduring aspect of people's personalities, which reflects (1) being more aware of their feelings and sense of self, and (2) feeling a sense of choice with respect to their behavior. The SDS is a short, 10-item scale, with two 5-item subscales. The first subscale is awareness of oneself and the second is perceived choice in one's actions. Items prompt participants to estimate which of two statements feels more true of them, for example "what I do is often not what I'd choose to do" versus "I am free to do whatever I decide to do". The subscales may be used separately (range 5-25) and combined into an overall SDS score (range 10–50).

Exercise-related

The locus of causality for exercise scale (LCE; Markland 1999) assessed the perceived choice (or autonomy) regarding performing PA. It is a 3-item scale and indicates the extent to which respondents feel that they choose to exercise rather than feeling that they have to, addressing the source of the initiation of behavior. An internal locus of causality is evident when an individual engages in a behavior freely and with no sense of coercion. The LCE is designed to sit comfortably with the intrinsic motivation inventory items (IMI, see below). In fact, a central feature of self-determination is the perception of choice, which the IMI does not evaluate (Deci and Ryan 1985). Responses to the LCE are scored on a Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree) combining in a total score (range 3–21) with high scores indicating greater self-determination or a more internal perceived locus of causality.

The exercise self-regulation questionnaire (SRQ-E; Ryan and Connell 1989) assessed domain-specific individual differences in types of motivation or regulation (regulatory motives for exercise, referring to the “what” of goal pursuit). The regulatory styles, while considered individual differences, are not “trait” concepts, for they are not general nor particularly stable. There are four different types of behavioral regulation, defined in terms of the degree to which the regulation of an extrinsically motivated activity has been internalized and integrated. The SRQ-E is structured so that it asks one question and provides responses that represent the different forms of regulation.

Participants have to choose, for each one of the 16 items (four for each subscale), how they feel in a 7-point Likert scale, ranging from 1 (not at all true) to 7 (very true). Each scale is scored separately by averaging the responses to each of the subscale’s items (range 4–28). Examples of items included in different regulations subscales, ordered from the least to the most fully internalized, are: external regulation (e.g., “Because I feel like I have no choice about exercising; others make me do it”), introjected regulation (e.g., “Because I would feel bad about myself if I did not”), identified regulation (e.g., “Because it feels important to me personally to accomplish this goal”). Intrinsic regulation: (“Because it is a challenge to accomplish my goal”, “Because it is fun”).

The intrinsic motivation inventory (IMI; McAuley et al. 1989), measured participants’ subjective experience related to exercise in the dimensions of interest/enjoyment (e.g., “I enjoy getting involved in physical activities very much”), perceived competence (e.g., “I think I do pretty well at physical activities, compared to others”), effort/importance (e.g., “It is important for me to do well at physical activities”), and pressure/tension (e.g., “I am usually anxious when I engage in physical activities”), each with four items. The pressure/tension scale was reversed as low pressure is associated with higher intrinsic motivation. Analyses were performed for the four subscales and the average of all 16 items

was also computed to provide a single score indicating overall level of exercise motivation (range 1–5), with higher scores indicating a more internal, self-regulated type of motivation.

The exercise motives inventory-2 (EMI-2; Markland and Ingledew 1997) assessed exercise participation motives (participatory motives, referring to the “why” of goal pursuit). The scale contains a total of 51 items, grouped in scales (in alphabetical order): affiliation, appearance, challenge, competition, enjoyment, health pressures, ill-health avoidance, nimbleness, positive health, revitalization, social recognition, strength and endurance, stress management, and weight management. The stem was “Personally, I exercise (or might exercise)...”. The response options ranged from not at all true for me (0) to very true for me (5). These scales can also be used combined, reflecting five dimensions: psychological motives, interpersonal motives, health-related motives, body-related motives and fitness-related motives (range 0–5).

Physical activity

The 7- day physical activity recall (7Day-PAR; Blair et al.1985; Hayden-Wade et al. 2003) was used to determine the duration and intensity of physical activities. Trained interviewers asked participants to recall time spent doing PA for the past 7 days (or typical week of last month, if last week was atypical), guiding the participants through the recall process, day by day. Previous studies have supported the reliability and validity of the 7-Day PAR as a measure of PA (Washburn et al. 2003). For the current study activity, reports were summarized into total minutes of moderate or vigorous intensity physical activity (METs >3.0) in a week.

Participants carried a Yamax Digi-Walker SW-200 step counter (New Lifestyles, Lee’s Summit, MO, USA) for assessment of daily steps (Welk et al. 2000; Le Masurier and Tudor-Locke 2003). Participants were instructed to place the pedometers on each morning and to

reset the device to zero each day. Subjects then wore the pedometers over the course of the entire day (during 1 week, including weekend days). Data from the pedometers were processed on a daily basis and averaged across 7 days to reflect typical daily steps for the week; mean steps per day were computed.

A lifestyle physical activity index was specifically developed for this study as a simple self-administered instrument for measuring habitual lifestyle physical activities typical of the last month. This variable is typically not available in existing PA questionnaires. To calculate this index we used a score based on seven questions (using stairs or escalators; walking instead of using transportation; parking away from destination; using work breaks to be physically active; choosing to stand up instead of sit; choosing hand work instead of mechanic/automatic; choosing to be physical active whenever possible). Options ranged from never (1) to always (5) on a Likert scale.

Statistical analyses

Analyses were carried out using SPSS 17.0 software (SPSS Inc., Chicago, IL, USA). Internal consistency estimates and descriptive statistics were calculated for all dependent variables. Primary analysis included only subjects for whom weight data were available at 12 months (completers, $n = 203$), 86% retention. Additionally, to account for potential selective dropout biases known to limit completers-only analyses, we also performed analyses including all 239 women who started the program and had valid data, carrying forward the baseline value for weight, a conservative estimate procedure (Ware 2003). For further insight into attrition-related bias, statistical comparisons of weight loss and demographic variables at baseline were conducted between the 12-month completers and the women who dropped out during first year.

To quantify the impact of the 1-year intervention on SDT treatment and exercise-related psychosocial variables, lifestyle PA, and weight and body composition changes, effect sizes were calculated. Effect size (or Cohen's *d*) is a standardized measure of the magnitude of the observed effect (e.g., difference between intervention and control groups). Cohen (1988) proposed widely accepted criteria for the magnitude of the effect: <0.30 small effect size; 0.30–0.80 medium effect size; >0.80 large effect size. Independent samples *t*-tests were carried out to analyze differences in self-regulation psychosocial variables, weight loss, body composition, and physical activity between intervention and control groups, at the end of intervention. This option was justified by the absence of several baseline SDT measures; because some questionnaires pertained intervention-related aspects (e.g., perceived autonomy support by the intervention team), they could not be assessed at baseline. Regarding exercise psychosocial measures, the questionnaire used to assess self-regulation (SRQ-E) did not contemplate a scale of amotivation (a completely non-self determined form of regulation reflecting a state of lacking any intention to engage in a exercise behavior); thus, given the fact that our baseline sample was mostly sedentary, responses to self-regulation and locus of causality for exercise questionnaires (e.g., ‘‘I try to exercise on a regular basis because...’’) were deemed as less valid at baseline and not used (also for consistency with the analysis for treatment-related variables).

Nevertheless, we compared baseline scores between intervention and controls for general self-determination variables (e.g., SDS). Rank-order correlation (Spearman's ρ) was used to estimate the relationship between adherence (displaying a non-normal distribution, thus warranting the use of this non-parametric technique) and main outcomes.

To test within and between-group differences during the course of the intervention (4-month and 12-month), a 2 X 2 repeated measures multivariate analysis of variance (GLM) was

conducted, comparing weight change and psychosocial self-regulation scores between intervention and controls.

RESULTS

The baseline characteristics of the 239 participants who initiated the study are given in Table 1. No differences between intervention and control groups were observed for demographic, physical activity, weight, and body composition variables. We also compared the groups for general self-determination and also found no differences ($P>0.05$).

Table 1 Baseline characteristics

	Intervention	Control
Demographics		
Age (years)	38.1 ± 7.04	37.1 ± 6.99
Higher education	64%	69%
Single	30%	37%
Married	56%	54%
Divorced, widow	14%	9%
Body habitus		
Height (m)	1.61 ± 0.06	1.61 ± 0.06
Weight (kg)	82.1 ± 11.9	81.5 ± 12.1
Body mass index (kg/m ²)	31.7 ± 4.24	31.3 ± 4.00
Body fat (%)	43.7 ± 4.9	44.1 ± 4.94
Fat mass (kg)	36.0 ± 8.42	36.0 ± 8.04
Lean mass (kg)	45.5 ± 5.12	45.0 ± 6.13
Physical activity		
Moderate + vigorous (min/week)	110.2 ± 150.1	88.6 ± 122.3
Lifestyle activity index	2.79 ± 0.88	2.89 ± 0.83

Data are given as mean ± SD or %. There were no significant differences (independent *t*-test) between intervention and control groups

According to established exclusion criteria (see “[Methods](#)”) subjects for whom health issues (non-intervention related), menopause, or pregnancy occurred during the intervention were

removed from analyses. At 12 months, 31 subjects (eight in the intervention group) had dropped out from the study. Reasons for attrition are explained in Fig. 1. Thus, 208 women were available for assessments at treatment's end (13% attrition). We compared completers and dropouts for age ($P = 0.127$), BMI ($P = 0.211$), and several demographic characteristics (e.g., marital status, $P = 0.796$; level of education, $P = 0.857$) and found no differences. Additionally, four women were excluded from statistical analysis because they had data which were not considered valid: two women with extreme weight and body composition data values (above four standard deviation units from mean) and two women who reported a very high level of difficulty understanding questionnaire instructions and written questions. In some analyses, due to occasional incomplete questionnaire data, a smaller number of subjects were considered.

Self-regulation for treatment and exercise

Results for self-regulation psychosocial variables can be seen in Table 2. For each scale/sub-scale, internal consistency coefficients were calculated. In most cases, observed Cronbach alpha values were greater than 0.80. Participants in the intervention group reported higher levels of self-determination (awareness of self and perceived choice) and autonomous self-regulation for treatment, and a more autonomy supportive perceived treatment climate. The same pattern of results was observed for exercise-related targets such as exercise intrinsic motivation, autonomous self-regulation, internal locus of causality, and exercise psychological and fitness motives, with participants in the intervention group scoring significantly higher in these variables. Comparing intervention and controls at 12 months, intervention targets such as more autonomous self-regulation (for treatment and for exercise), intrinsic motivation, psychological motives (related to fun, challenge), and a more autonomy perceived treatment climate revealed medium to large effect sizes, favoring intervention. Conversely, motives

related to interpersonal and body attractiveness reasons, and external regulation showed small or negative effect sizes.

Physical activity

As depicted in Table 2, participants in the intervention group showed significant higher levels of PA at 12 months, reflected in more steps per day ($+2,049 \pm 571$) and substantially more minutes of moderate and vigorous PA ($+138 \pm 26$) per week, compared to controls. Results for the lifestyle PA index also confirm the intervention group as being significantly more active.

Weight and body composition

Weight outcomes were expressed as percent weight change from baseline (Fig. 3). At 12 months (and already at 4 months) participants in the intervention group achieved more weight loss compared to controls. The mean difference between groups at the end of the intervention was of about 6%. Following intention-to-treat principles (ITT) and including all starting subjects in statistical analysis, we used baseline imputation for the 31 dropouts. Whether or not ITT were adopted, this had no effect on the study inference (differences between the two groups remained highly statistically significant).

Concerning changes in body composition at 12 months, the intervention group lost 5.6 ± 4.1 kg of fat mass (vs. -1.5 ± 4.3 kg in the control group, $P < 0.001$ for between-group difference), and showed -1.1 ± 1.8 kg of change in lean mass (vs. -0.2 ± 1.6 kg, $P < 0.001$). Percent body fat changed by $-6.9 \pm 7.9\%$ in the intervention group (vs. $-2.5 \pm 7.5\%$, $P < 0.001$). BMI change also differed significantly ($P < 0.001$) between the two groups: -2.3 ± 1.9 kg/m² for intervention and 0.7 ± 1.9 kg/m² for controls.

Table 2 Between-group comparison for psychosocial and exercise variables (12 months)

Psychosocial variables	Alpha	Intervention control		<i>t</i>	ES
		Mean ± SD	Mean ± SD		
Treatment-related, general					
Health care climate	.96	93.1 ± 11.2	78.5 ± 16.6	−7.40***	1.06
Treatment self-regulation					
Controlled	.86	23.7 ± 9.03	22.5 ± 8.03	−0.93	0.14
Autonomous	.79	32.9 ± 2.78	26.9 ± 6.14	−9.09***	1.35
Self-determination					
Awareness of self	.67	20.6 ± 3.32	19.5 ± 3.62	−2.15*	0.32
Perceived choice	.84	17.8 ± 3.88	16.2 ± 4.68	−2.44*	0.35
Total score	.81	38.3 ± 5.96	35.8 ± 7.15	−2.74**	0.40
Exercise-related					
Locus of causality for exercise	.80	16.2 ± 4.43	13.1 ± 4.76	−4.76***	0.68
Exercise intrinsic motivation					
Enjoyment/interest	.89	4.14 ± 0.74	3.65 ± 0.89	−4.21***	0.60
Perceived competence	.80	3.27 ± 0.91	2.78 ± 0.94	−3.66***	0.53
Pressure/tension	.82	4.12 ± 0.72	3.78 ± 0.79	−3.08**	0.45
Effort/importance	.82	3.94 ± 0.73	3.46 ± 0.79	−4.34***	0.68
Total score	.94	3.99 ± 0.62	3.54 ± 0.70	−4.77***	0.69
Exercise self-regulation					
External	.72	7.53 ± 3.56	7.89 ± 3.61	0.70	−0.10
Introjection	.67	11.3 ± 4.48	8.84 ± 3.39	−4.42***	0.65
Identification	.85	26.1 ± 1.98	22.7 ± 4.53	−7.12***	1.05
Intrinsic	.87	24.0 ± 3.89	18.9 ± 5.62	−7.59***	1.08
Motives for exercise					
Psychological	.91	3.77 ± 0.77	3.29 ± 0.80	−4.22***	0.61
Interpersonal	.78	1.73 ± 1.02	1.71 ± 0.83	−1.71	0.03
Health	.90	3.64 ± 0.66	3.65 ± 0.75	0.11	0.01
Body	.84	3.94 ± 0.71	3.84 ± 0.79	−0.91	0.13
Fitness	.87	4.06 ± 0.72	3.81 ± 0.78	−2.27*	0.35
Physical activity variables					
Moderate + vigorous (min/week)		300 ± 179	162 ± 171	−5.31***	0.79
Steps/day		9902 ± 3331	7852 ± 3470	−3.59***	0.60
Lifestyle activity index	0.84	3.84 ± 0.69	2.98 ± 0.81	−7.33***	1.14

* $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$ for *t*-test comparing intervention and control groups at 12 months; α Cronbach's alpha, *SD* standard deviation, *ES* Cohen's *d* effect size (between-group differences)

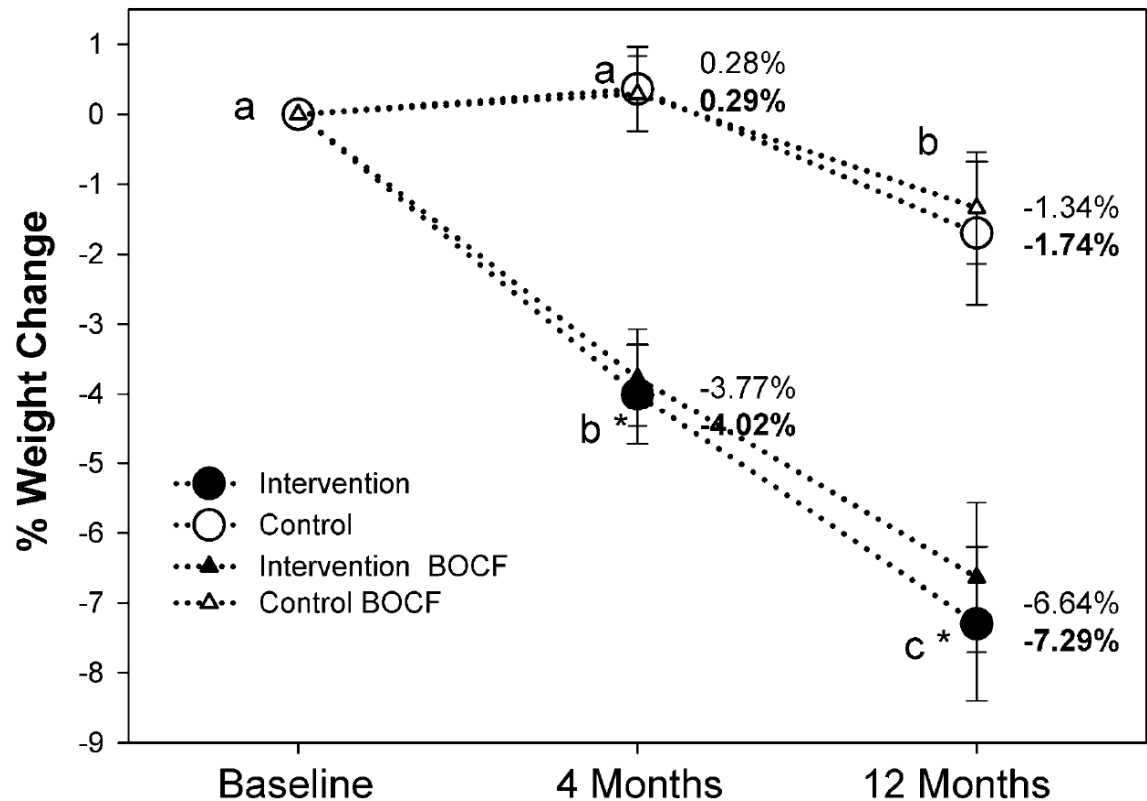


Figure 3. Weight change during the first year for intervention and control groups.

Errors bars show 95% confidence interval. To evaluate the pattern of change in weight, GLM repeated measures were used. There was a significant time x group interaction at 4 and 12 months, compared to baseline ($P < 0.001$). Mean values with the same superscript letter are not different ($P > 0.05$) within intervention and control groups. * $P < 0.001$ between groups at each time point for completers-only and baseline observation carried forward (BOCF) analysis.

Adherence to the weekly or bi-weekly scheduled intervention sessions (mean $87.2 \pm 12.9\%$, median 90.5%) was also considered. Changes in BMI, weight loss, percentage of body fat, and number of steps per day were significantly correlated with adherence ($P < 0.003$). An efficacy analysis using only participants who attended 80% or more intervention sessions (79% of intervention group participants) showed the following intervention-control differences: $-5.9 \pm 0.7\%$ ($-5.5 \pm 0.8\%$ for all intervention completers) in % body weight change, $+156 \pm 27$ min/week ($+138 \pm 25$ for all intervention completers) in moderate and vigorous PA, $+2.298 \pm 585$ steps/day ($+2.049 \pm 571$ for all intervention completers) in walking, and large effect sizes

regarding the lifestyle index (0.95) and more autonomous forms of regulation for exercise (0.99 identified and 1.12 intrinsic), favoring intervention. All differences were significant at $P < 0.001$.

Group specific time-course of changes in self-regulation

We also wanted to examine and compare group-specific time-course of changes in autonomous self-regulation for exercise during the program. This was assessed using GLM repeated-measures to determine whether there were significant main effects of time, group, and group X time. Results can be seen in Fig. 4. There was a significant main effect of group on autonomous forms of self-regulation, i.e., intrinsic ($F = 47.7, P < 0.001$) and identification ($F = 47.8, P < 0.001$), and on introjection ($F = 20.5, P < 0.001$) with higher scores for the intervention group, and also a time effect for introjection ($F = 50.95, P < 0.001$) with a decrease in both groups. There were a significant time X group effects for intrinsic ($F = 8.90, P = 0.003$), identification ($F = 9.05, P = 0.003$), and external regulation ($F = 4.05, P = 0.045$), indicating that between-group differences at 4 months were accentuated at 12 months.

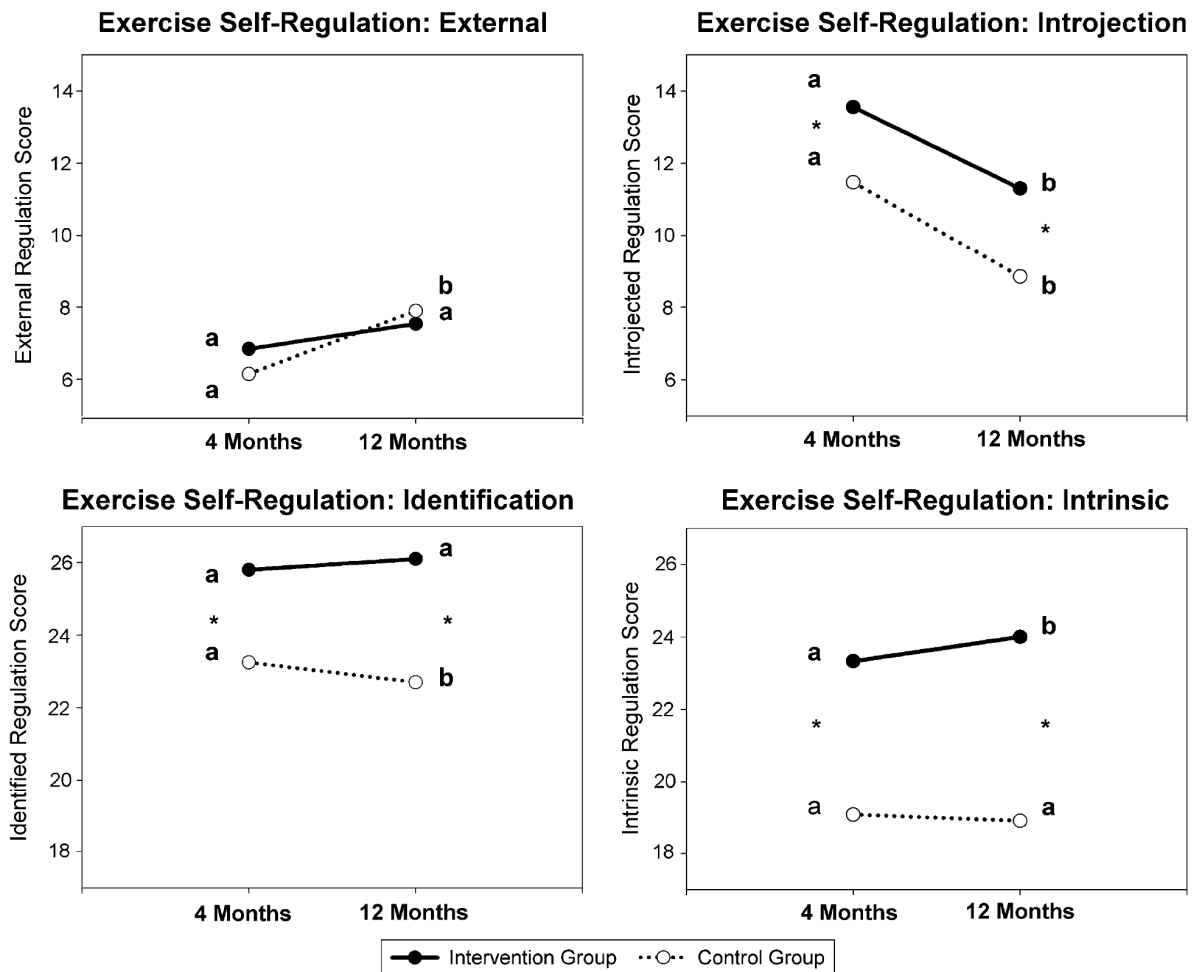


Figure 4. Changes in self-regulation for exercise at 4 and 12 months

GLM repeated measures were used. Same superscript letter indicates no differences ($P > 0.05$), within intervention and control groups. * Indicates differences ($P < 0.05$) between groups at each time point

DISCUSSION

The use of theory-based intervention studies helps discern which components work to produce expected outcomes, and to what extent. Furthermore, research and application have recursive effects, each enhancing the quality and relevance of the other. A recent review on existing behavioral interventions for preventing and treating obesity in adults (Sharma 2007) found that the majority were not based on any explicit behavioral theory, and that approximately half

of the interventions were less than 6 months in duration. Moreover, the most common outcome for measuring the impact of the interventions was weight or BMI, with energy balance-related behaviors being infrequently measured. Even interventions which used behavior theories did not, typically, measure changes in constructs that could predict behavior. Such measurements are critical for identifying the most salient constructs and for increasing their predictive potential, as well as for improving theory itself. In comparison to other aspects of SDT framework, research focusing on manipulating socio-environmental context has been limited. Considering previous reports (Williams et al. 2002; Edmunds et al. 2008), more studies, using more sophisticated experimental designs, are needed. We developed a RCT with a novel intervention grounded on SDT, where group differences in general self-determination, and in perceived autonomy support, intrinsic motivation, perceived competence, and autonomous regulation for treatment and PA were evaluated after a 12-month group-based behavioral program in premenopausal women.

The large intervention effect size observed for perceived autonomy-promoting treatment climate adds evidence to previous research demonstrating that, when treatment staff are characterized by minimizing pressure and control, understanding participant's perspectives, and regular provision of choices rather than fixed prescriptions (Williams et al. 1998, 2004, 2006) they are perceived by participants as being more autonomy-supportive, ensuing self-determined motivational regulations. At intervention's end, participants in the experimental condition, compared to controls, also reported more autonomous self-regulation (for treatment and for exercise), higher exercise intrinsic motivation and perceived competence, a more internal locus of causality, and more autonomous motives for exercise. Furthermore, other differences between control and intervention groups support that the intervention also tapped into more general aspects of self-determination (e.g., awareness of self). Taken collectively, results show significant intervention effects on SDT-related variables.

To analyze the intervention effects along the time course of the program, namely the internalization of a more autonomous exercise regulations process, we compared psychosocial scores between intervention and controls at 4 and 12 months. This assessment scheme was useful because, as noted in the “[Methods](#)” section, the intervention was implemented in sequential modules; for instance, the physical activity main self-regulation components were implemented progressively, starting approximately at week 10. In agreement, intrinsic and identified self-regulation increased with time in the intervention group with significant time X group effects, confirming that the intervention program increased the process of internalization of autonomous self-regulation for exercise along time, during the first year. These findings add credence to SDT’s arguments that social-contextual characteristics of health interventions are amenable to manipulation and play an important role in facilitating the internalization process (Ryan and Deci [2000](#)). When an autonomy-supportive climate is present, it is postulated that the regulation of behavior will be perceived by the participant as his/her own, and the most autonomous forms of regulation will arise (Deci et al. [1994](#); Edmunds et al. [2008](#)).

A critical outcome of this intervention was exercise/PA at intervention’s end. Regarding moderate plus vigorous PA, the average of about 300 min per week is consistent with current physical activity recommendations to achieve meaningful health benefits and also to help sustain weight loss (Saris et al. [2003](#); Donnelly et al. [2009](#)). A previous study with overweight sedentary women enrolled in a 12-month behavioral intervention showed that weight loss was significantly greater in the group reporting more than 200 min per week of exercise, especially compared with the group with less than 150 min/week (Jakicic et al. [2003](#)). For daily walking, although mean steps per day for the intervention group did not reach the 10 000 steps a day recommendation (Tudor-Locke and Bassett [2004](#)), these women reported about 2 000 steps/day more than controls, a reasonable intervention effect. This variable reflects all

walking, some of which is strongly influenced by the physical/built environmental and other contextual influences (e.g., job-, and family-related) less likely to be changed, compared to other types of physical activity. Perhaps more sensitive to intervention influences was the variable we named lifestyle PA, including parking further away from one's destination, taking the stairs more often, standing instead of sitting, etc., for which a large effect size favoring intervention was observed. This outcome is frequently omitted in PA studies. However, because the 7-day PAR includes moderate plus vigorous PA in bouts of activity longer than 10 min, it is possible for an individual to accumulate a substantial amount of lower-intensity daily PA but still report little or no moderate/vigorous exercise. Also, because steps per day include planned and unplanned walking, pedometry could not specifically capture these daily lifestyle changes. In fact, the lifestyle index and steps/day were only moderately correlated (results not shown).

Regarding weight loss and changes in body composition, results are in line with the other outcomes already discussed. It is important to notice that at 12 months (as well as at 4 months), comparing to controls, participants in the intervention group not only achieved significantly more weight loss, but the relative amount of weight loss from baseline ($7.3 \pm 5.9\%$) is consistent with recommendations regarding the magnitude of weight loss necessary to reduce health risk (Donnelly et al. 2004). The average of 7% is also consistent with outcomes achieved in some of the most intensive and comprehensive lifestyle change programs (Tuomilehto et al. 2001; McBride et al. 2008). For changes in body composition, results showed that the weight lost in the intervention group was largely due to fat mass (percent body fat was reduced by $6.9 \pm 7.9\%$). A recent review confirmed the selective effect of exercise on body composition in people who are overweight or obese (Shaw et al. 2006).

This study has some limitations that need to be acknowledged. First, the nature of the control group precluded a direct comparison of this intervention with other types of weight loss

programs. The decision for a standard care control group, which is common in this type of research (e.g., Williams et al. 2006), was related to other goals of this RCT, namely testing the motivational sequence embedded in SDT, which might facilitate our understanding of the mechanisms that foster self-determined motivation for exercise in weight loss settings. A second limitation concerns the lack of baseline assessments for exercise and treatment-related outcomes (an option justified in the “Methods” section). Despite the fact that there were no differences regarding demographic and more general SDT variables (such as causality orientations and general self-determination), the possibility that groups differed at baseline cannot entirely be ruled out. The lack of an economic evaluation of the intervention can also be considered as a study limitation, to be addressed in future research. Translational studies involving cost-effectiveness analyses represent an important research need in the behavioral sciences to optimize associated economic and clinical benefits for both society and participants involved. Since the present trial was primarily concerned with studying mechanisms of behavior change and identifying individual-level predictors of success, cost analyses were unfortunately not planned and could not be calculated post-hoc.

In summary, this SDT-based intervention for weight control appears to have been well-implemented, resulting in meaningful changes in exercise/PA behavior, and changes in weight and body composition of clinical relevance. Results at 1 year provide a positive answer to Michie and Abraham’s (2004) two questions regarding RCTs, namely (1) “does it work?”: we demonstrated that the intervention produced measurable improvements in main outcomes and psychological theory-grounded variables, relative to an appropriate control group; and (2) “how well does it work?”: moderate to strong effect sizes were observed, favoring the intervention. All participants are now being followed for two additional years to evaluate weight maintenance and other relevant long-term processes and outcomes.

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REFERENCES

- Blair, S. N., Haskell, W. L., Ho, P., Paffenbarger, R. S., Jr., Vranizan, K. M., Farquhar, J. W., et al. (1985). Assessment of habitual physical activity by a 7-day recall in a community survey and controlled experiments. *American Journal of Epidemiology*, 122(5), 794–804.
- Catenacci, V. A., & Wyatt, H. R. (2007). The role of physical activity in producing and maintaining weight loss. *Nature Clinical Practice Endocrinology & Metabolism*, 3(7), 518–529.
- Chatzisarantis, N., & Hagger, M. (2009). Effects of an intervention based on self-determination theory on self-reported leisure-time physical activity participation. *Psychology and Health*, 24(1), 29–48.
- Cohen, J. (1988). *Statistical power analysis for the behavioural sciences*. Hillsdale: Lawrence Earlbaum Associates.
- Cooper, Z., & Fairburn, C. G. (2001). A new cognitive behavioural approach to the treatment of obesity. *Behaviour Research and Therapy*, 39(5), 499–511.
- Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating internalization: the self determination theory perspective. *Journal of Personality*, 62(1), 119–142.

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deci, E., & Ryan, R. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology*, 49(3), 182–185.

Donnelly, J. E., Blair, S. N., Jakicic, J. M., Manore, M. M., Rankin, J. W., & Smith, B. K. (2009). American college of sports medicine position stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Medicine and Science in Sports and Exercise*, 41(2), 459–471.

Donnelly, J. E., Smith, B., Jacobsen, D. J., Kirk, E., Dubose, K., Hyder, M., et al. (2004). The role of exercise for weight loss and maintenance. *Best Practice & Research Clinical Gastroenterology*, 18(6), 1009–1029.

Edmunds, J., Ntoumanis, N., & Duda, J. (2008). Testing a self-determination theory-based teaching style intervention in the exercise Domain. *European Journal of Social Psychology*, 38, 375–388.

Fortier, M. S., Sweet, S. N., O’Sullivan, T. L., & Williams, G. (2007). A self-determination process model of physical activity adoption in the context of a randomized controlled trial. *Psychology of Sport and Exercise*, 8, 741–757.

Hayden-Wade, H. A., Coleman, K. J., Sallis, J. F., & Armstrong, C. (2003). Validation of the telephone and in-person interview versions of the 7-day PAR. *Medicine and Science in Sports and Exercise*, 35(5), 801–809.

Jakicic, J. M., Marcus, B. H., Gallagher, K. I., Napolitano, M., & Lang, W. (2003). Effect of exercise duration and intensity on weight loss in overweight, sedentary women: A randomized trial. *Jama*, 290(10), 1323–1330.

LeMasurier, G. C., & Tudor-Locke, C. (2003). Comparison of pedometer and accelerometer accuracy under controlled conditions. *Medicine and Science in Sports and Exercise*, 35(5), 867–871.

Markland, D. (1999). Self-Determination moderates the effects of perceived competence on intrinsic motivation in an exercise setting. *Journal of Sport and Exercise Psychology*, 21, 351–361.

Markland, D., & Hardy, L. (1997). On the factorial and construct validity of the intrinsic motivation inventory: conceptual and operational concerns. *Research Quarterly for Exercise and Sport*, 68(1), 20–32.

Markland, D., & Ingledew, D. (1997). The measurement of exercise motives: factorial validity and Invariance across gender of a revised exercise motivation inventory. *British Journal of Health Psychology*, 2, 361–376.

Martinez-Gonzalez, M. A., Varo, J. J., Santos, J. L., De Irala, J., Gibney, M., Kearney, J., et al. (2001). Prevalence of physical activity during leisure time in the European Union. *Medicine and Science in Sports and Exercise*, 33(7), 1142–1146.

Mata, J., Silva, M. N., Vieira, P. N., Carraca, E. V., Andrade, A. M., Coutinho, S. R., et al. (2009). Motivational “spill-over” during weight control: Increased self-determination and exercise intrinsic motivation predict eating self-regulation. *Health Psychology*, 28(6), 709–716.

Mcauley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the intrinsic motivation inventory in a competitive sport setting: a confirmatory factor analysis. *Research Quarterly for Exercise and Sport*, 60(1), 48–58.

Mcbride, P. E., Einerson, J. A., Grant, H., Sargent, C., Underbakke, G., Vitcenda, M., et al. (2008). Putting the diabetes prevention program into practice: A program for weight loss and cardiovascular risk reduction for patients with metabolic syndrome or type 2 diabetes mellitus. *The Journal of Nutrition, Health & Aging*, 12(10), 745s–749s.

Michie, S., & Abraham, C. (2004). Interventions to change health behaviours: evidence-based or evidence-inspired? *Psychology and Health*, 19, 29–49.

Rose, E., Parfitt, G., & Williams, G. (2005). Exercise causality orientations, behavioral regulation for exercise and stage of change for exercise: Exploring their relationships. *Psychology Sport Exercise*, 6, 399–414.

Rutten, A., & Abu-Omar, K. (2004). Prevalence of physical activity in the European Union. *Preventive Medicine*, 49(4), 281–289.

Ryan, R., & Connell, J. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, 57, 749–761.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and wellbeing. *American Psychologist*, 55(1), 68–78.

Ryan, R., Frederick, C., Lipes, D., Rubio, N., & Sheldon, K. (1997). Intrinsic motivation and exercise adherence. *International Journal of Psychology*, 28, 335–354.

Saris, W. H., Blair, S. N., Van Baak, M. A., Eaton, S. B., Davies, P.S., Di Pietro, L., et al. (2003). How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st stock conference and consensus statement. *Obesity Reviews*, 4(2), 101–114.

Sharma, M. (2007). Behavioural interventions for preventing and treating obesity in adults. *Obesity Reviews*, 8(5), 441–449.

Shaw, K., Gennat, H., O’rourke, P. & Del Mar, C. (2006). Exercise for overweight or obesity. *Cochrane Database Syst Rev*(4): CD003817.

Sheldon, K., Ryan, R., & Reis, H. (1996). What makes for a good day? *Personality and Social Psychology Bulletin*, 22, 1270–1279.

Sheldon, G., Williams, G., & Joiner, T. (2003). *Self-determination theory in the clinic: Motivating physical and mental health*. New Haven: Yale University Press.

Silva, M. N., Markland, D. A., Minderico, C. S., Vieira, P. N., Castro, M. M., Coutinho, S. R., et al. (2008). A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: Rationale and intervention description. *BMC Public Health*, 8(1), 234.

Spiegel, A. M., & Alving, B. M. (2005). Executive summary of the strategic plan for national institutes of health obesity research. *American Journal of Clinical Nutrition*, 82(1 Suppl), 211S–214S.

Teixeira, P. J., Going, S. B., Houtkooper, L. B., Cussler, E. C., Metcalfe, L. L., Blew, R. M., et al. (2006). Exercise motivation, eating, and body image variables as predictors of weight control. *Medicine and Science in Sports and Exercise*, 38(1), 179–188.

Teixeira, P. J., Silva, M. N., Coutinho, S. R., Palmeira, A. L., Mata, J., Vieira, P. N., et al. (2009). Mediators of weight loss and weight loss maintenance in middle-aged women. *Obesity (Silver Spring)* Aug 20 [Epub ahead of print].

Thogersen-Ntoumani, C., & Ntoumanis, N. (2006). The role of self-determined motivation in the understanding of exercise-related behaviours, cognitions and physical self-evaluations. *Journal of Sports Sciences*, 24(4), 393–404.

Tudor-Locke, C., & Bassett, D. R., Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine*, 34(1), 1–8.

Tuomilehto, J., Lindstrom, J., Eriksson, J. G., Valle, T. T., Hamalainen, H., Ilanne-Parikka, P., et al. (2001). Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of Medicine*, 344(18), 1343–1350.

Varo, J. J., Martinez-Gonzalez, M. A., De Irala-Estevez, J., Kearney, J., Gibney, M., & Martinez, J. A. (2003). Distribution and determinants of sedentary lifestyles in the European Union. *International Journal of Epidemiology*, 32(1), 138–146.

Ware, J. H. (2003). Interpreting incomplete data in studies of diet and weight loss. *New England Journal of Medicine*, 348(21), 2136–2137.

Washburn, R. A., Jacobsen, D. J., Sonko, B. J., Hill, J. O., & Donnelly, J. E. (2003). The validity of the Stanford 7-day physical activity recall in young adults. *Medicine and Science in Sports and Exercise*, 35(8), 1374–1380.

Welk, G. J., Differding, J. A., Thompson, R. W., Blair, S. N., Dziura, J., & Hart, P. (2000). The utility of the Digi-walker step counter to assess daily physical activity patterns. *Medicine and Science in Sports and Exercise*, 32(9 Suppl), S481–S488.

Williams, G. C., Freedman, Z. R., & Deci, E. L. (1998). Supporting autonomy to motivate patients with diabetes for glucose control. *Diabetes Care*, 21(10), 1644–1651.

Williams, G. C., Gagne, M., Ryan, R. M., & Deci, E. L. (2002a). Facilitating autonomous motivation for smoking cessation. *Health Psychology*, 21(1), 40–50.

Williams, G. C., Grow, V. M., Freedman, Z. R., Ryan, R. M., & Deci, E. L. (1996). Motivational predictors of weight loss and weight loss maintenance. *Journal of Personality and Social Psychology*, 70(1), 115–126.

Williams, G. C., McGregor, H. A., Sharp, D., Levesque, C., Kouides, R. W., Ryan, R. M., et al. (2006). Testing a self-determination theory intervention for motivating tobacco cessation: Supporting autonomy and competence in a clinical trial. *Health Psychology*, 25(1), 91–101.

Williams, G. C., McGregor, H. A., Zeldman, A., Freedman, Z. R., & Deci, E. L. (2004). Testing a self-determination theory process model for promoting glycemic control through diabetes self-management. *Health Psychology, 23*(1), 58–66.

Williams, G. C., Minicucci, D. S., Kouides, R. W., Levesque, C. S., Chirkov, V. I., Ryan, R. M., et al. (2002b). Self-determination, smoking, diet and health. *Health Education Research, 17*(5), 512–521.

Wilson, D. K., Evans, A. E., Williams, J., Mixon, G., Sirard, J. R., & Pate, R. (2005). A preliminary test of a student-centered intervention on increasing physical activity in underserved adolescents. *Annals of Behavioral Medicine, 30*(2), 119–124.

Wilson, P., & Rodgers, W. (2003). The relationship between perceived autonomy support exercise regulations and behavioural intentions in women. *Psychology of Sport and Exercise, 5*, 229–242.

Wilson, P. M., Rodgers, W. M., Fraser, S. N., & Murray, T. C. (2004). Relationships between exercise regulations and motivational consequences in university students. *Research Quarterly for Exercise and Sport, 75*(1), 81–91.

Wing, R., & Hill, J. (2001). Successful weight loss maintenance. *Annual Review Nutrition, 21*, 323–341.

CHAPTER 5

Helping overweight women become more active: Need support and motivational regulations for different forms of physical activity³

“How does it work?”

“Mediational analyses of the relationship between theoretically-predicted psychological antecedents and intervention-induced behavior change can clarify underlying mechanisms, the underlying psychological changes that account for observed behavior change.”

Michie & Abraham, 2004, p. 35

³ Silva, M.N., Markland D., Vieira P.N., Coutinho, S.R., Carraça, E.V., Palmeira, A.L., Minderico, C.S., Matos, M.G, Sardinha, L.B., Teixeira, P.J.(2010). Helping Overweight Women Become More Active: Need Support and Motivational Regulations for Different Forms of Physical Activity. *Psychology of Sport and Exercise*. doi:10.1016/j.psychsport.2010.06.011.

ABSTRACT

Objectives: This study analyzed mechanisms by which a one-year obesity treatment intervention based on self-determination theory (SDT) influenced physical activity level and whether motivational predictors differed for structured versus lifestyle forms of physical activity. *Design:* Randomized controlled trial lasting 1-year. *Method:* Pre-menopausal overweight and obese women ($n=239$; $37.6\pm 7.1y$; $31.5\pm 4.1\text{kg/m}^2$) participated in a group intervention designed to increase physical activity and motivation, following SDT. Partial least squares (PLS) latent variable modeling was used to test a cross-sectional multiple-level mediation model comprising experimentally-manipulated contextual need support, perceived need satisfaction, and motivational regulations for two distinct forms of physical activity.

Results: The structural model explained a large amount of variance (62%) for intrinsic motivation, and moderate amounts of variance (16%-25%) for the remaining regulations and exercise behaviors. Moderate and vigorous exercise was positively influenced by intrinsic motivation ($p<0.001$) whereas lifestyle physical activity was not significantly predicted by motivational regulations. Behavioral regulations were influenced by perceived autonomy and perceived competence and both needs were affected by contextual support from treatment climate ($p<0.001$). *Conclusions:* Results provide support for using the SDT framework to understand physical activity motivational processes in the context of weight management. Results also highlight structured and lifestyle physical activity as being promoted by different processes as a result of the intervention: more direct effects on lifestyle physical activity and indirect effects on structured exercise, mediated by intrinsic motivation.

This trial is registered at ClinicalTrials.gov (NCT00513084).

Key Words: Theory-Based Intervention; Randomized Controlled Trial; Mediation; Self-Determination; Exercise; Obesity

INTRODUCTION

Given the high rates of sedentarism (Abu-Omar, Rutten, & Robine, 2004; Varo et al., 2003) and the well-established positive role of physical activity for successful long-term weight control (Donnelly et al., 2009), a thorough understanding of the determinants and mechanisms of physical activity adoption and maintenance is highly relevant in the context of obesity. Motivation is a critical variable in exercise adherence, and a clear understanding of motivational processes underlying the decision to be physically active and persist in this behavior should provide useful insights for the promotion of long-term physical activity adoption. To meet this goal, theoretically-grounded longitudinal empirical studies are an important requisite. A growing body of research has provided evidence supporting self-determination theory (SDT) as a comprehensive motivational framework for understanding physical activity and other health behaviors (Deci & Ryan, 1985, 2008; Wilson, Mack, & Grattan, 2008). The present study expands on previous work by providing a multiple-level mediation test of causal mechanisms of behavior (exercise/physical activity) as put forth by SDT, in the context of obesity lifestyle treatment, following current research recommendations for identifying effective strategies for exercise sustained participation (USDHHS, 2008).

The conceptual basis of SDT is organized into several micro-theories. One of these, organismic integration theory (OIT) (Deci & Ryan, 1985) specifies that people can be motivated for different reasons, which can be conceptualized as lying along a continuum of relative autonomy or the extent to which the regulation of a behavior has been internalized into the person's sense of self. External regulation occurs when a person performs activities either to obtain rewards or to avoid punishment or sanctions administered by others.

Introjected regulation concerns performance motivated by self-esteem-related contingencies (prideful when performing well, guilty when doing poorly) and is a partially internalized form of regulation. Identified regulation is a more autonomous form of motivation and occurs when the person experiences an activity as personally valuable or important to the self, such as exercising to maintain one's health. Integrated regulation emerges when the person engages in a behavior because it is consistent with their core values and beliefs. Intrinsic motivation, the fully autonomous form of motivation, is present when an activity is engaged in because of its inherent satisfactions such as for the fun, interest, or the challenge it offers. Research clearly shows that more autonomous regulatory motives (identified, integrated, and intrinsic) are conducive to greater long-term behavioral adherence in the domains of exercise (Edmunds, Ntoumanis, & Duda, 2006; Edmunds, Ntoumanis, & Duda, 2007; Fortier, Sweet, O'Sullivan, & Williams, 2007; Ingledeu & Markland, 2008; Ingledeu, Markland, & Ferguson, 2009) and weight management (Powers, Koestner, & Gorin, 2008; Teixeira et al., 2006; Teixeira et al., 2009; Williams, Grow, Freedman, Ryan, & Deci, 1996).

A fundamental premise of SDT is that the internalization of more external behavioral regulations is fostered by the satisfaction of three basic psychological needs. Basic needs theory (BNT) (Ryan & Deci, 2000) specifies this notion, proposing that human beings have innate psychological needs for autonomy (fulfilled when people perceive that they are the origin of their choices and decisions, and that they are acting in accordance with their integrated sense of self and personal values), competence (concerning an individual's need to feel a sense of mastery through effective interaction within their environment), and relatedness (concerning having satisfying and supportive social relationships). OIT and BNT are closely linked. Indeed, to the extent that the social environment (e.g., intervention climate) provides support for the three needs, more self-determined forms of behavioral regulation will be promoted. Based on previous research (Deci & Ryan, 2000; Koestner & Losier, 2002) a recent

study examined specific differential mediating effects of psychological need satisfaction in the relation between support for psychological needs and the internalization of behavioral regulation for exercise (Markland & Tobin, 2010). The results supported the central role afforded to autonomy in SDT, and indicated that autonomy was essential for the internalization of behavioral regulation. Koestner and Losier (2002) indicated that relatedness is less salient for intrinsic regulation because people can be intrinsically motivated when engaging in solitary activities (Deci & Ryan, 2000). Instead, competence and autonomy need satisfaction promote intrinsic motivation because this form of regulation involves being drawn to engage in activities that provide the individual with opportunities for experiencing enjoyment, optimal challenges, and the exercise of their skills. Thus, it is reasonable to assume that the need for supportive social interactions would be less salient to their intrinsic motivation.

Besides proposing that the effects of social contextual factors on self-determined motivation are mediated by psychological need satisfaction (Guay, Boggiano, & Vallerand, 2001; Markland & Tobin, 2010), the theory further specifies three socio-contextual factors which are held to correspond to the development of a need supportive environment (Markland, Ryan, Tobin, & Rollnick, 2005; Reeve, 2002; Ryan & Deci, 2002). The first is autonomy support, which involves the minimization of controls, offering choice, encouraging individuals to initiate actions for their own reasons and in line with their personal goals and values without pressuring compliance, and listening with empathy and acknowledging that behavioral change is demanding and challenging from the participants perspective). The second is structure, which involves helping individuals to develop clear expectations, explaining behavior-outcome contingencies, encouraging competence and giving positive feedback. The final factor is involvement, which concerns understanding other people's perspectives, providing unconditional, non-contingent and non-judgmental positive regard and demonstrating genuine

concern for their well-being. Using an experimental design (by varying instructional style in group-based educational classes), a recent study showed that these SDT-based social-contextual characteristics, and psychological needs, predicted autonomous regulations and adaptive outcomes in terms of exercise adherence and affect (Edmunds, Ntoumanis, & Duda, 2008). Williams and colleagues have also found that greater perceptions of a more need supportive environment from one's health care provider facilitates the development of more autonomous regulations for smoking cessation (Williams, Gagne, Ryan, & Deci, 2002; Williams et al., 2006).

In exercise settings, a growing body of empirical findings has linked contextually promoted satisfaction of autonomy and competence with autonomous regulations (identified and intrinsic) and physical activity (Edmunds et al., 2007; Wilson & Rodgers, 2003; Wilson, Rodgers, Fraser, & Murray, 2004). However, it is presently unclear which type(s) of autonomous regulations is/are more closely associated with particular behavior outcomes and how this association may vary as a function of the targeted behavior (Burton, Lydon, D'Alessandro, & Koestner, 2006). Future studies on motivational predictors need to be more specific about the type of exercise behavior under examination, as different types of physical activity may be guided by different mechanisms, as demonstrated in a recent study, where introjected regulation, identified regulation, and intrinsic motivation were associated positively with strenuous and total exercise behaviors but failed to be significantly correlated with moderate and mild forms of exercise behavior (Edmunds et al., 2006).

Physical activity behavior is a broad construct that can be separated into several different components. A major distinction is that between formal/planned activities and informal/unplanned (lifestyle physical activity), in which individuals deliberately increase activity as a part of their daily routines (Donnelly et al., 2009). In the context of obesity treatment, physical activity, especially structured exercise, has been positively associated with

successful long-term weight control in cross-sectional, retrospective and longitudinal studies (see USDHHS, 2008 for a review). In addition to the well-established benefits of moderate/vigorous structured exercise, some studies (Andersen et al., 1999; Dunn et al., 1999) suggest that lifestyle activity can also help participants improve health and fitness, and maintain their weight loss.

Whilst both structured and lifestyle physical activities may be important for weight management, they typically involve different intensities and may involve different potential for enjoyment and different levels of cognitive processing. Lifestyle and unstructured daily opportunities for being active (e.g., taking the stairs instead of elevators, parking away from destination, walking as a transportation) may represent habitual and automatically enacted behaviors. This notwithstanding, these behaviors can be experienced as self-determined by the individual, because self-determination does not mean controlled by the person, it means endorsed by the self (see Levesque et al., 2008 for a review). A recent study (Legault, Green-Demers, & Eadie, 2009) tested the notion that self-determined motivation may be internalized to the point that regulation becomes automatic. According to this internalization automatization hypothesis, it is theorized that entrenched, rehearsed, and personally-important self-determined goals will be made chronically accessible to the point of automaticity. For example, the goal to be physically active can become habitually and automatically linked to the ways or means by which it is achieved on a daily basis. On the basis of their results, Burton et al. (2006) speculated that internalizing the importance of a goal, as in identified self-regulation, might lead individuals to build mental scripts for pursuing their goals that subsequently they are able to follow in relatively automatic fashion. This and other studies, although not addressing the issue of automaticity, have shown identified regulation as the strongest predictor for behaviors considered important but not inherently interesting (where the pursuit of the behavior itself fails to invoke uniformly high levels of intrinsic interest) (e.g.

Edmunds et al., 2006). This may be the case for routine informal and unstructured daily opportunities for being active, where identified regulation may be a more salient predictor of task involvement than intrinsic motivation.

For structured physical activity (e.g., leisure-time brisk walks in nature, recreational sports, swimming or biking), typically of moderate or vigorous intensity, people may find the pursuit of the behavior itself sufficiently interesting to regulate participation for no separable consequence besides enjoyment, fun, novelty, challenge, or to re-discover new sensations and feelings (Deci & Ryan, 2008). Indeed, from the viewpoint of SDT, structured physical activity can be an inherently rewarding activity that satisfies psychological needs and contributes to both happiness and subjective vitality (Deci & Ryan, 2000; Ryan, Frederick, Lipes, Rubio, & Sheldon, 1997). Thus, this type of physical activity could be regulated more by intrinsic motivation, which in turn is hypothesized to be predicted by the experienced satisfaction of the needs for both competence and autonomy.

Grounded in the previous theoretical and empirical propositions and fueled by the need to identify and test the processes or mechanisms by which theoretical predictors influence exercise behavior (Hagger & Chatzisarantis, 2008), we aimed to confirm the causal processes and mechanisms by which treatment promoted different form of physical activity, during a one-year obesity treatment intervention based on SDT (Silva et al., 2008; Silva et al., 2010). Indeed, research on treatment-induced mediators of behavior change may be of help in identifying potential causal mechanisms through which interventions operate and outcome-focused randomized controlled trials provide the ideal setting for such work (Kraemer, Wilson, Fairburn, & Agras, 2002). We hypothesized that the intervention would enhance physical activity participation through promoting a climate in which psychological needs would be satisfied which in turn would facilitate the internalization of regulations for

exercise. It was also expected that different mechanisms would predict different types of physical activity. The following specific hypotheses were tested:

1) The intervention program will enhance the perceived need support experienced by intervention participants, leading in turn to the experience of autonomy and competence need satisfaction.

2) Perceived autonomy and competence will mediate the relationship between need support and behavioral regulations, and be positive predictors of autonomous regulations (intrinsic and identified) and negative predictors of controlled regulations (external and introjected).

3) More autonomous regulations (intrinsic and identified) will positively predict exercise participation, whereas more controlled regulations (external and introjected) will not affect or will be detrimental to exercise participation, as they may predict only short-term participation (Pelletier, Fortier, Vallerand, & Briere, 2001)

4) The influence of the intervention program on different types of physical activity through need support and need satisfaction will be mediated by different regulatory processes; intrinsic motivation will primarily mediate the relationship with structured moderate/vigorous physical activity, while identified regulation will be the key mediator for lifestyle physical activity.

METHOD

Study Design and Intervention

The study was part of a randomized controlled trial in a Portuguese sample of overweight and obese women including a 1-year behavior change intervention focused on increasing exercise self-motivation and exercise adherence, aiming at long-term weight control (Silva et al.,

2008)¹. The Ethics Committee of the Faculty of Human Kinetics – Technical University of Lisbon reviewed and approved the study.

Entering in three successive annual cohorts, participants were randomly assigned to intervention and control groups. Group treatment during the first year was delivered following a detailed session-by-session protocol describing the topics to be covered and the manner in which they were to be addressed. Protocol implementation and participant care were facilitated by holding regular meetings to discuss these issues and manipulation checks were conducted by a senior interventionist during randomly assigned sessions to assess fidelity in delivering the protocol (both in person and with taped sessions). Throughout the same year, experimental groups received an approximately equivalent amount of face-to-face contact with treatment providers, but sessions (29 in the control group, 30 in the intervention group, lasting about 120 min each.) differed in terms of contents and interpersonal climate. The control group received a general health education curriculum based on educational courses, covering various topics not directly related to weight control (e.g., preventive nutrition, stress management, self-care, and effective communication skills). The interpersonal climate promoted in this condition was similar to that commonly observed in standard health care settings: choices, rationale and explanations were limited; goals were not set; minimal feedback was provided (Sheldon, Williams, & Joiner, 2003). Primary targets of the intervention included increasing physical activity and energy expenditure, adopting a diet consistent with a moderate energy deficit, and ultimately establishing exercise and eating patterns that would support sustained weight loss.

Intervention principles and style of intervention were based on SDT, with a special focus on increasing competence and intrinsic motivation towards exercise and weight control. In order to assure competences regarding the promotion of an autonomous treatment climate, all intervention staff received specific training in the form of workshops and formal and informal

training meetings, conducted by in-house as well as external experts in the fields of SDT and Motivational Interviewing. The staff work involved helping participants to develop clear expectations, encouraging them to believe that they were capable of successfully engaging in weight control activities, encouraging choice, self-initiation and independent problem-solving, providing informational feedback that guided the individual towards a meaningful rationale for change, and making perspective-acknowledging statements. A large range of options was also provided, supporting autonomous decisions during the program, helping individuals to recognize that they could exercise choice and self-direction regarding their behavior, and encouraging participants to explore their own motivations for treatment and define their personal treatment goals, while limiting external contingencies and controls (Edmunds et al., 2008; Markland et al., 2005; Reeve, 2002). Along with more theoretical sessions to build sustainable knowledge that supported informed choices, and training in issues related to safety and skills (e.g., self-monitoring), there was also a dance curriculum to explore fun and awareness of the body in mindful movement. Also, some workshops focused on the development of strategies and skills that would allow participants to intentionally increase their daily energy expenditure. These focused for instance on developing problem solving skills and allowing a new and more proactive look at daily opportunities to be active (both in formal and informal physical activities), as well as overcoming barriers such as lack of time and opportunities. Accordingly, participants were encouraged to accumulate short bouts of physical activity in their daily routines, such as increasing the amount of walking and using stairs whenever possible, this way accumulating daily physical activity minutes in a way uniquely adapted to each person's lifestyle. A full description of the study's theoretical rationale, protocol, and intervention strategies can be found elsewhere (Silva et al., 2008; Silva et al., 2010).

Participants

Participants were recruited from the community at large through media advertisements. By design, only pre-menopausal women ($n=258$) were accepted into the study. Of these, 19 women were subsequently excluded from all analyses because they started taking medication likely to affect weight ($n=10$), had a serious chronic disease diagnosis or severe illness/injury ($n=4$), became pregnant ($n=2$) or entered menopause ($n=3$). There were no significant differences between these 19 women and the 239 participants considered as the valid initial sample by age ($t= .561, p= .575$), education ($t=4.510, p=1.01$), marital status ($t= .593, p= .743$), or BMI ($t= -.811, p=.418$). The remaining participants were between 23 and 50 years old (38 ± 6.8 years) and were overweight or mildly obese, with an initial mean BMI of 31.3 ± 4.1 kg/m². Women in the intervention group ($n=123$) did not differ from those in the control group ($n=116$) in terms of BMI ($t= -.895, p=.372$), age ($t= -1.254, p=.211$), education ($t=.503, p=.615$), or marital status ($t= -1.451, p=.148$). There were also no differences between the 208 women who completed the 12-month intervention and the 31 who quit the program for any demographic or baseline psychosocial variable, with the exception of age; women who stayed in the program were on average four years older ($t=3.036, p=.01$). Retention rates were 93% (intervention) and 79% (control).

Measurements

All assessment sessions occurred in the Faculty of Human Kinetics Health and Exercise Laboratory, and were conducted in standardized conditions of comfort and silence, supervised/conducted by trained technicians (Silva et al, 2008). For the present study only the 1-year assessment period was considered, thus all the data reported are cross-sectional (see the statistical analyses section for a more in-depth explanation).

Need Support From the Intervention Staff

Participants' *perceived need support*, which concerns the quality of the social environment, was assessed by the Health Care Climate Questionnaire (HCCQ) (Williams et al., 1996). Although HCCQ has traditionally been considered to measure autonomy support, it also addresses support for competence, with items related to the provision of structure (e.g., "practitioners made it clear what I need to do to") and relatedness support, with items measuring involvement (e.g., "practitioners handle peoples' emotions very well"). Responses to the 15 items were rated on a 7-point Likert-type scale ranging from 1=*strongly disagree* to 7= *strongly agree*). Although items in the HCCQ tap into different underlying dimensions of support, they are highly inter-related; thus, a total score was calculated. As in previous studies (Markland & Tobin, 2010; Niemiec et al., 2006), the term 'need support' will be used in the current paper to refer to the supportive intervention environment.

Need Satisfaction

Perceived autonomy was assessed by the Locus of Causality for Exercise Scale (LCE) (Markland & Hardy, 1997). This 3-item scale indicates the extent to which respondents feel that they choose to exercise rather than feeling that they have to exercise (e.g., "I exercise because I like to rather than because I feel I have to"). The perceived locus of causality construct addresses the source of behavior initiation; an internal locus of causality is evident when an individual engages in a behavior freely and with no sense of coercion. Responses to the LCE are scored on a Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree), with high scores indicating greater self-determination or a more internal perceived locus of causality.

Perceived competence was assessed with the four items from the perceived competence subscale of the Intrinsic Motivation Inventory (McAuley, Duncan, & Tammen, 1989)

referring to exercise in general (e.g., “I think I do pretty well at physical activities, compared to others”). Responses were scored on a five-point scale ranging from 0 to 5, with high scores indicating higher perceived competence for physical activity.

Behavioral Regulations of Exercise

The types of regulation for exercising (source level motives for exercise) were measured with the Exercise Self-Regulation Questionnaire (SRQ-E) (Ryan & Connell, 1989). The SRQ-E assesses four different types of behavioral regulations, defined in terms of the degree to which the regulation of an extrinsically motivated activity has been internalized and integrated. The SRQ-E is structured so that it asks one question and provides responses that represent the different forms of regulation. Participants have to indicate, for each of the 16 items (4 for each subscale), how they feel on a 7-point Likert scale, ranging from 1 (not at all true) to 7 (very true). Each scale is scored separately (by averaging the responses to each of the subscale's items). Examples of items included in different regulations subscales are (in order from the least to the most fully internalized): External Regulation (e.g., “Because I feel like I have no choice about exercising; others make me do it”), Introjected Regulation (e.g., “Because I would feel bad about myself if I did not”), Identified Regulation (e.g., “Because it feels important to me personally to accomplish this goal”) and Intrinsic motivation: (e.g., “Because it is a challenge to accomplish my goal”, “Because it is fun”). In common with other measures of the exercise behavioral regulation continuum (e.g., the Behavioural Regulation in Exercise Questionnaire-2 (Markland & Tobin, 2004), the SRQ-E does not include an integrated regulation subscale, apparently because it was difficult to empirically distinguish between integration and identified regulation on the one hand and intrinsic regulation on the other hand.

Physical Activity

Structured/formal physical activity was expressed by the total minutes of moderate or vigorous intensity physical activity (METs >3.0) in a week, assessed by the Seven-Day Physical Activity Recall (7-Day PAR)(Blair et al., 1985; Hayden-Wade, Coleman, Sallis, & Armstrong, 2003). Trained interviewers asked the participants to recall time spent doing physical activity for the past 7 days (or a typical week of last month, if last week was atypical). Previous studies have supported the reliability and validity of the 7-Day PAR as a measure of physical activity in adults (Washburn, Jacobsen, Sonko, Hill, & Donnelly, 2003).

Routine daily lifestyle physical activity was assessed by a *Lifestyle Physical Activity Index*, from a questionnaire specifically developed for this study, measuring habitual lifestyle physical activities typical of the last month. This is a variable typically not available in existing physical activity questionnaires. To calculate the Lifestyle Physical Activity Index we used a score based on 7 questions (“Using stairs or escalators”; “Walking instead of using transportation”; “Parking away from destination”; “Using work breaks to be physically active”; “Choosing to stand up instead of sitting”; “Choosing manual work instead of mechanical/automatic”; “Choosing to be physically active whenever possible”). The response options ranged from *never* (1) to *always* (5) on a Likert scale.

Statistical Analyses

Model testing was conducted using partial least squares (PLS) analysis with the SmartPLS Version 2.0 (M3) software (Ringle, Wende, & Will, 2006). PLS was developed (Wold, 1985) as a general method for the estimation of path models involving latent constructs indirectly measured by multiple indicators. Chin (1998) described PLS as comprising two models: (1) a measurement model, also called the outer model, specifying the relationships between latent variables (LVs) and their associated observed or manifest variables (MVs); (2) a structural

model, also called the inner model, relating some LVs to other LVs. By using an iterative estimation method that minimizes residual variance by providing successive approximations for the estimates of loadings and path parameters, PLS allows that the resulting component score for each latent variable is based on the best estimated indicator weights; consequently it maximizes the variance explained for the dependent variables (i.e., latent, observed, or both).

While covariance-based modeling (e.g., LISREL) requires a large number of cases relative to the number of parameters in the model to be estimated, PLS is ideally suited for use with smaller sample sizes (Chin, 1998) due to the partial nature of the estimation procedure, with only one part of the model being estimated at each time. The model in the present study comprised 8 latent variables with 44 observed indicators. Given the sample size available (146 following deletion of missing data, see below), the covariance-based modeling approach would have been impractical. In PLS analysis, with models comprising only reflective latent variables, the recommended minimum sample size is ten times the number of structural paths leading to the endogenous latent variable with the largest number of such paths (Chin & Newsted, 1999). For the present model, this amounted to four paths, and a minimum sample size of 40, which was far exceeded with the current data. Following the recommendations of Hulland (1999), the PLS model was analyzed in two stages, testing first the adequacy of the measurement model and then assessing the structural model.

Testing of the measurement model included first the estimation of individual item reliability. For reliability of an indicator, the standardized loading of the indicator on its intended latent variable should be statistically significant and higher than .40 (Hulland, 1999). Next, the internal consistency of the latent variables was assessed by examining their composite reliabilities (CR). According to Fornell & Larcker (1981) a CR of .70 or higher represents acceptable internal consistency. CR is considered superior to Cronbach's alpha reliability coefficient, providing a better estimate of variance shared by a set of indicators because the

former does not assume equal weightings of items. Next, convergent and discriminant validity of the scales was assessed by examining the average variance extracted (AVE) for the scales (Fornell & Larcker, 1981). The AVE is the average amount of variance in a set of indicators explained by their latent variable. Regarding convergent validity, the AVE should be at least .50 (i.e., the latent variable explains on average 50% or more of the variance in its indicators). Regarding discriminant validity of the latent variables, the average variance shared between a latent variable and its indicators should be greater than the variance shared between the variable and other latent variables in the model. Thus, discriminant validity is satisfied when a latent variable's AVE is greater than the squared bivariate correlations between it and the other latent variables in the model.

The testing of the structural model included first the estimation and testing of the significance of the structural path coefficients and the indirect effects of the latent variables through intervening variables. SmartPLS implements a bootstrapping procedure to estimate means and standard errors for the estimates which can then be tested for significance by the *t*-statistic (note: because bootstrap procedures do not assume normality of the distribution, they provide stronger protection against type II error (MacKinnon, Lockwood, & Williams, 2004). In the present analyses, 5000 bootstrap samples with replacement were requested. Next, the relative amount of 'explained' or 'reproduced' variance of LVs (R^2) was examined. Because Smart PLS does not generate significance tests for the R^2 values for latent variables, effect sizes of the R^2 values (Cohen's f^2) were calculated to show whether the amount of variance explained is negligible, small (<.15), medium (<.35) or large (>.35) (Cohen, 1988).

Tests of mediation were conducted by examining the significance of the indirect paths that emerged from the independent to the dependent variables, using the bootstrapping procedures incorporated in SmartPLS. When examining mediating effects, past work has shown the bootstrapping approach to be superior to the alternative methods of testing indirect effects,

such as the Sobel test, with respect to power and Type I and II error rates (MacKinnon et al., 2004). The significance of the indirect effects was analyzed both in the absence of the intervening variable(s) (total effects, denoted C paths) and in their presence (direct effects, denoted C' paths). Baron and Kenny (1986)'s formal steps for testing mediation were followed: (a) the independent variable must have an effect on the dependent variable; (b) the independent variable must have an effect on the intervening variable(s); and (c) intervening variable(s) must affect the outcome, after controlling for the independent variable. To establish full mediation, the total effect of the independent variable on the outcome (C path) must become non-significant in the presence of the intervening variable(s) (C' path), while the indirect effect is significant. Partial mediation is established when the C' path remains significant but is substantially reduced and the indirect effect is significant. Finally, effect ratios were calculated to express the amount of the total effect that is explained by the indirect effects via the mediator(s). This is a preferable (quantitative) way to describe mediated effects, overcoming the full/partial mediation dichotomous distinction, provided that no suppression effects are present in the model (Shrout & Bolger, 2002). One reason to include a control group resides in the fact that mediation analyses (to identify the most relevant processes of change associated with the primary outcomes) require a standard control group when conducted in the context of a randomized controlled trial (Kraemer et al., 2002). Analyses are potentially facilitated by maximizing effect sizes between intervention and controls.

Absolute scores (assessed at 12 months) were used for all analyses. This choice was based on the fact that not all psychosocial variables were assessed at baseline. Most participants did not engage in regular exercise at the beginning of the intervention, which would therefore have yielded less valid exercise psychosocial measures (e.g., Self-regulation "I exercise because I"; locus of causality for exercise "I try to exercise on a regular basis because..."). Also, perceived need support from health care climate could only be assessed after the start of the

intervention. For consistency, we decided to also use physical activity measures at 12 months, instead of change in physical activity. Nevertheless, we compared baseline scores between intervention and controls for general self-determination variables (e.g., SDS) and for exercise minutes, and no differences were found ($p>0.05$).

Results

The central focus of this study was to test a theoretically-based process model by which the intervention produced its effects on different types of physical activity. The *main effects* of the intervention trial on putative mediators and outcomes are reported in detail elsewhere (Silva et al., 2010). Briefly, group differences in key intervention targets were medium to large favoring the intervention group (all $ps<0.001$), including perceived need supportive environment, need satisfaction, autonomous self-regulation and exercise. In the current study the effective sample size at 12 months following listwise deletion of missing data was 146. *t*-tests comparing the valid dataset group vs. the missing dataset group were performed and no significant differences were found between the two groups. This suggests analyses should yield unbiased parameter estimates (Schafer & Graham, 2002). The mean age of the effective sample was 36.6 (*SD* 7.0 years) and the mean body mass index was 30.2 (*SD* 4.3 kg/m²).

Measurement Model

Initial measurement model analysis showed that one observed Introjected Self-Regulation indicator had a negative and very low factor loading (-.031) and that the AVE with this indicator included was below the acceptable level (.35). Thus, this item was eliminated and the model re-estimated. PLS and bootstrapped estimates for all factor loadings were greater than .40 (only seven loadings were less than .70) and significantly greater than zero in all cases. Need Support had loadings between .59 and .89 ($p<0.001$), Perceived Autonomy had loadings between .72 and .90 ($p<0.001$), Perceived Competence had loadings between .69 and

.84 ($p < 0.001$), External Self-Regulation had loadings between .59 and .81 ($p < 0.001$), Introjected Self-Regulation had loadings between .50 and .97 ($p < 0.01$), Identified Self-Regulation had loadings between .77 and .90 ($p < 0.001$), Intrinsic Motivation had loadings between .81 and .90 ($p < 0.001$) and the Lifestyle Physical Activity Index had loadings between .57 and .81 ($p < 0.001$).

Table 1 shows the CRs, AVEs, and correlations among the variables in the model. CRs were all greater than .70 and AVEs were greater than .50, indicating acceptable convergent validity for the items. AVEs for each latent variable were greater than the squared bivariate correlations with all the other latent variables, indicating acceptable discriminant validity of the scales. Correlation coefficients matched expected patterns of association grounded in SDT and supported a simplex-like pattern among the behavioral regulations (Ryan & Connell, 1989). Treatment and Perceived Need Support by the health care climate were correlated with key self-regulatory variables and Perceived Autonomy and Perceived Competence were positively associated with more autonomous self-regulations and negatively with external ones. All the LVs (with exception of external regulation) were correlated with physical activity variables. Taken together, these analyses suggest acceptability of the measurement model.

Structural Model

Figure 1. shows the PLS and bootstrapped parameter estimates for the structural paths, and the variance accounted for in the dependent variables (R^2). Group randomization (intervention vs. control conditions) positively predicted need support, which in turn positively predicted satisfaction of the basic needs for autonomy and competence. Autonomy negatively predicted external regulation and both autonomy and competence positively predicted introjected, identified and intrinsic motivations. Only one path between behavioral regulations and

physical activity behaviors emerged as significant, with intrinsic motivation positively predicting structured moderate-vigorous physical activity. The model explained between 6% and 62% of the variance in the variables. The variances explained in perceived autonomy ($f^2 = .06$), perceived competence ($f^2 = .10$), and external regulation ($f^2 = .11$) were small. Moderate amounts of variance were explained for perceived need support ($f^2 = .20$), introjected regulation ($f^2 = .31$), identified regulation ($f^2 = .34$), and physical activity variables: moderate and vigorous ($f^2 = .21$) and lifestyle physical activity ($f^2 = .19$). For the remaining variable, intrinsic motivation, a large amount of variance was explained ($f^2 = 1.62$).

Table 1*Composite Reliability (CR), Average Variance Extracted (AVE) and Correlations of Factors in the Measurement Model*

Factor	CR	AVE	Correlations												
			1	2	3	4	5	6	7	8	9	10			
1. Treatment	-	-	-												
2. Need Support	.98	.65	.41 ***	-											
3. Perceived Autonomy	.87	.68	.24 **	.24 **	-										
4. Perceived Competence	.85	.59	.25 **	.30 ***	.55 ***	-									
5. External Self-Regulation	.82	.54	-.08	-.15	-.30 ***	-.23 **	-								
6. Introjected Self-Regulation	.74	.51	.35 ***	.33 ***	.42 ***	.46 ***	.02	-							
7. Identified Self-Regulation	.91	.72	.45 ***	.42 ***	.48 ***	.39 ***	-.10	.44 ***	-						
8. Intrinsic Self-Regulation	.92	.73	.43 ***	.48 ***	.73 ***	.65 ***	-.16 *	.50 ***	.76 ***	-					
9. Moderate & Vigorous Exercise	-	-	.35 ***	.26 ***	.35 ***	.33 ***	-.15	.22 **	.35 ***	.40 ***	-				
10. Lifestyle Physical Activity	.88	.51	.41 ***	.36 ***	.29 ***	.18 *	.06	.29 ***	.35 ***	.34 ***	.37 ***	-			

Note: N = 146

*p<.05, **p<.01, ***p<.001.

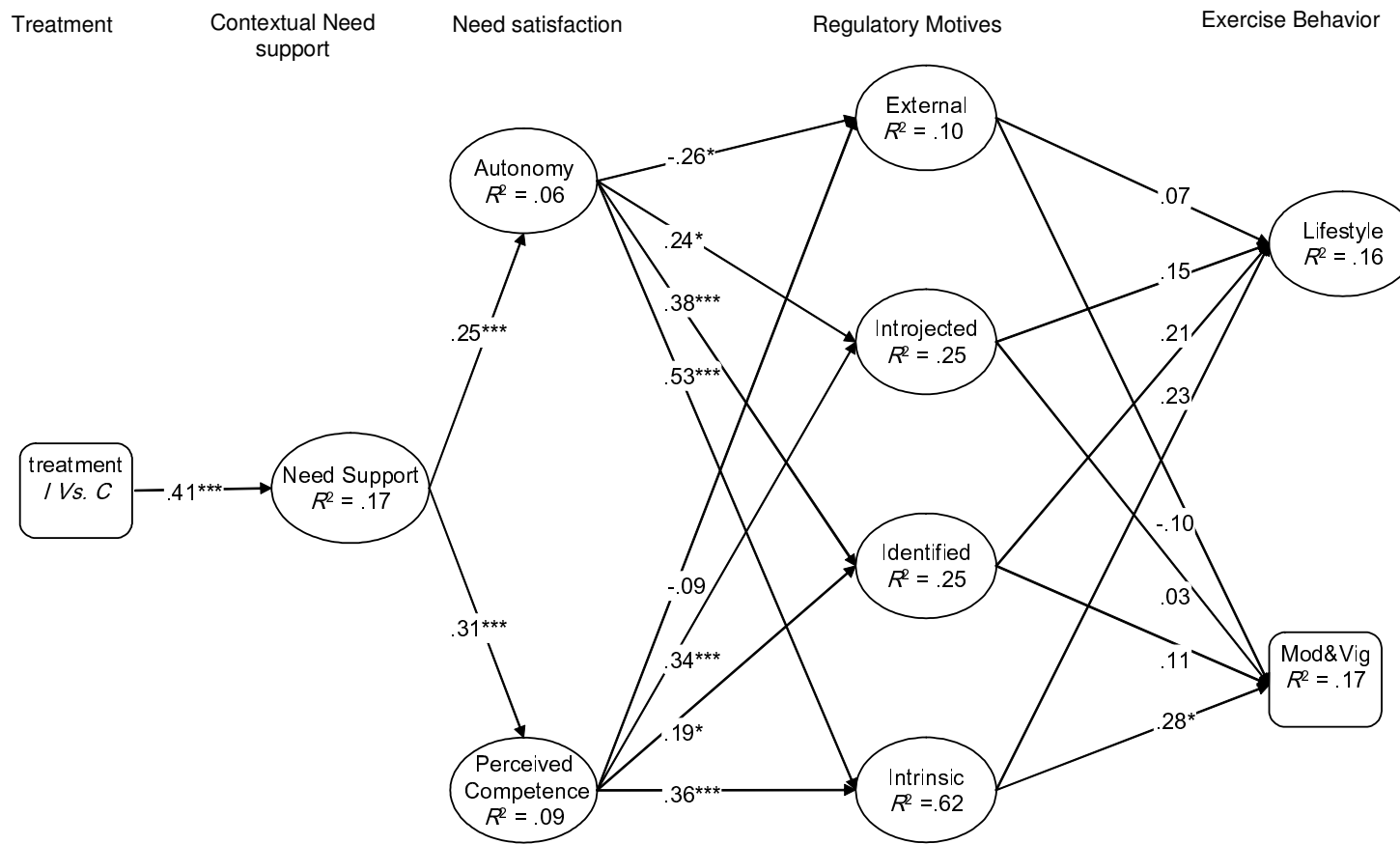


Figure 1. Partial least squares Model.

Values in the Paths represent the standardised bootstrap estimate, *p<.05, **p<.01, ***p<.001.

Table 2 shows the indirect effects where there were intervening variables. For all the possible combinations of intervening variables, significant indirect effects were found.

Table 2

Indirect Effects in the Structural Model

Relationship		Bootstrap
From	To	Estimate
Treatment	Perceived Autonomy	.11 **
Treatment	Perceived Competence	.13 ***
Treatment	External Regulation	-.04 *
Treatment	Introjected Regulation	.07 **
Treatment	Identified Regulation	.07 **
Treatment	Intrinsic motivation	.10 ***
Treatment	Moderate & Vigorous Exercise	.04 **
Treatment	Lifestyle Physical Activity	.04 *
Need Support	External Regulation	-.10 *
Need Support	Introjected Regulation	.17 ***
Need Support	Identified Regulation	.16 **
Need Support	Intrinsic motivation	.25 ***
Need Support	Moderate & Vigorous Exercise	.10 ***
Need Support	Lifestyle Physical Activity	.11 *
Perceived Autonomy	Moderate & Vigorous Exercise	.23 ***
Perceived autonomy	Lifestyle Physical Activity	.22 **
Perceived Competence	Moderate & Vigorous Exercise	.14 ***
Perceived Competence	Lifestyle Physical Activity	.16 **

Note: N = 146; Estimates represent 5000 bootstrapping testing

* $p < 0.05$, ** $p < .01$, *** $p < .001$

Results of the mediation analyses to explore the role of these SDT variables as mediators of the effects of intervention on moderate and vigorous and lifestyle physical activity, are expressed in

Table 3.

Table 3*Tests of Mediation in the Structural Model*

Relationship		Total effect	Direct effect	Effect Ratio
		(C path)	(C' path)	
From	To	Estimate	Estimate	
Treatment	Perceived Autonomy	.25 ***	.18	.42
Treatment	Perceived Competence	.27 ***	.17	.47
Treatment	Intrinsic motivation	.34 ***	.27 ***	.30
Treatment	Moderate & Vigorous Exercise	.24 ***	.22 ***	.17
Treatment	Lifestyle Physical Activity	.36 ***	.34 ***	.11
Need Support	Intrinsic motivation	.49 ***	.33 ***	.50
Need Support	Moderate & Vigorous Exercise	.17 ***	.10	.61
Need Support	Lifestyle Physical Activity	.31 ***	.24 **	.35
Perceived Autonomy	Moderate & Vigorous Exercise	.35 ***	.13	.64
Perceived Autonomy	Lifestyle Physical Activity	.35 ***	.11	.63
Perceived Competence	Moderate & Vigorous Exercise	.33 ***	.13	.43
Perceived Competence	Lifestyle Physical Activity	.25 *	.07	.64

Note: N = 146; Estimates represent 5000 bootstrapping testing

*p<.05, **p<.01, ***p<.001.

The effects of treatment on perceived autonomy and on perceived competence were totally mediated by perceived need supportive environment (effect ratios of .42 and .47, respectively). Furthermore, for moderate and vigorous physical activity, the effect of this supportive health care climate was totally mediated by both need satisfaction and intrinsic motivation, with 61 % of the total effect being explained by these particular indirect paths. More specifically, the effects of perceived autonomy and perceived competence on this type of physical activity outcomes were also totally mediated by intrinsic motivation (effect ratios of .64 and .43 respectively). Furthermore, treatment had significant indirect effects on moderate and vigorous physical activity through a partial mediation by perceived need supportive environment, need satisfaction, and intrinsic motivation (effect ratio.17). For lifestyle physical activity, despite the treatment

effect being mediated by autonomy and competence (effect ratios of .63 and .64 respectively), treatment also displayed a significant direct role on this outcome.

DISCUSSION

According to Shrout and Bolger (2002), mediation models of psychological processes allow interesting associations to be decomposed into components that reveal possible causal mechanisms. While a large body of research has established the efficacy and effectiveness of a range of psychological variables in treatments, it would be of great value to understand how they work, as research could then focus on enhancing the effective elements and discarding those found to be redundant (Murphy, Cooper, Hollon, & Fairburn, 2009). Randomized controlled trials provide an often-missed opportunity to investigate the mediators of treatment effects, and guidelines have been proposed for accomplishing this (Kraemer et al., 2002). Although a growing body of literature supports the utility of SDT as a useful framework to understand exercise promotion, no study has tested it in the context of a randomized controlled trial for exercise and weight control. The present work aimed at providing greater understanding of the role of motivational regulations influencing different physical activity behaviors, searching for specific, differential mechanisms by which the intervention produced its effects.

The model testing supported the acceptability of both the measurement and the structural models, and accounted for a substantial portion of the variance in intrinsic ($R^2=.62$), identified and introjected regulations ($R^2=.25$). The results were supportive of the proposed pattern of causal sequences and generally consistent with the specific hypotheses encapsulated by the model. Thus, aligned with the theoretical tenets of the SDT, the results revealed that the treatment condition increased participants' perceptions of a need supportive environment. In turn, this had positive effects on the satisfaction of the needs for autonomy and competence (supporting the

Chapter 5: Study III

first hypothesis), leading to more autonomous forms of exercise motivational regulations (as encapsulated in the second hypothesis). Autonomy need satisfaction emerged as a negative predictor of external regulation, but positively predicted the more self-determined motivations (identified and intrinsic). Competence also positively predicted autonomous motivations but had no effect on external regulation.

Contrary to our hypothesis regarding controlled regulations, need satisfaction had a positive effect on introjected regulation. A similar positive effect was also observed in a previous study where athletes' perceptions of coaches' autonomy support were positively associated with intrinsic motivation and identified regulation, as well as, albeit to a lesser extent, with introjected regulation (Pelletier et al., 2001). In the present study, the significant association between introjected and identified and intrinsic motivations (in the absence of a relation with external regulation) suggests that, in this sample, introjected regulation is closer to the autonomous regulations than to external regulation. Culture-specific aspects may help explain this finding. Introjected regulation is a partially internalized form of controlled regulation where a person is motivated by internally imposed controls and contingencies related to self-esteem. In a cultural background where external approval is learned to be contingent on compliance and conformity (e.g., to God or expert opinion), introjection could be a common form of motivational regulation. It might have been the case that, even when presented with a self-determination focused intervention climate, ego involvement of the participants became on average more pronounced. However, to fully understand the impact of autonomy and competence need satisfaction on introjection, research should examine the distinct regulatory styles at different levels of personality and take into account not only domain-specific factors but also situational (e.g., cultural) and dispositional influences. For example, Ingledew and Markland (2008) found that behavioral regulations were directly influenced by personality. In their study, conscientiousness

Chapter 5: Study III

had direct effects on external and introjected regulation. It could also be that differences in relatedness need satisfaction (not measured in the present study), particularly in relationship with need support and perceived autonomy, might have influenced the development of introjected regulation (Markland & Tobin, 2010). This notwithstanding, the observed positive association between need satisfaction and introjection should not be interpreted as advocacy for instilling feelings of guilt or contingent self-worth in individuals. Indeed, there is evidence demonstrating that introjected regulation typically results in behavior that is less stable, less persistent, and less coordinated with other aspects of the self than autonomous regulations (Pelletier et al., 2001). Accordingly, in the present study, introjected regulation failed to predict physical activity level at treatment end.

Despite the unexpected pattern for introjection, results suggests that in overweight/obese individuals, feelings of choice and volition about what types of activity are engaged in, as well as perceptions of competence that they can effectively perform the chosen activities, are important to the development of self-determined motivation towards exercise. Specific mediation tests also supported SDT assertions that the effects of social-contextual factors on self-determined motivation are mediated by psychological need satisfaction (Guay et al., 2001). The mediation results were also consistent with the model depicted in Figure 1, stressing that the experimental supportive context explained the adoption of moderate and vigorous physical activity by its effect on the satisfaction of autonomy and competence needs on intrinsic motivation. Indirect effects explained substantial proportions of total effects, consistent with the form of the model. These findings add credence to the theoretical proposition that the concepts of psychological needs and self-determined motivations are important because they can help researchers and practitioners identify the motivational constructs that are necessary for understanding the process of behavioral change (Hagger, Chatzisarantis, & Biddle, 2002; Wilson et al., 2008).

Chapter 5: Study III

Regarding our third and fourth hypotheses, results generally supported the expected pattern – a positive influence of intrinsic motivation on structured physical activity and a neutral or negative influence of external and introjected regulation on physical activity. Identified regulation was not a significant predictor of physical activity in the presence of the other regulations (despite a strong bivariate correlation with moderate and vigorous PA). Considering the high shared variance between the two autonomous forms of motivation in this sample, we interpret this finding simply as suggesting that intrinsic motivation is the stronger predictor of the two regulations. However, we cannot fully assert that identified regulations were not within the causal path of moderate and vigorous physical activity in this trial (note: when intrinsic motivation was not included in the model, identified regulation was the strongest mediator and highly significant; results not shown).

As it was mentioned in the introduction, differently from structured moderate and vigorous physical activity (which is more likely to need deliberate self-regulation), lifestyle physical activity, at least as it was assessed in the present study, is concerned with more habitual and automatically enacted behaviors. Thus, the processes by which the intervention promoted these two types of physical activity were different and more direct in the second case (lifestyle activity) – a behavior which is not as intrinsically motivating and that requires little competence. The absence of mediation effects of autonomous or controlled regulations for lifestyle physical activity in this study is consistent with Edmunds' (2006) research where exercise behavioral regulation was found to be predictive of vigorous and purposeful engagement in exercise but not for lower intensity incidental behaviors, suggesting that such habitual activities may require less cognitive processing than more structured and vigorous forms of exercise. Indeed, other social cognitive models have also been found to be poorly predictive of habitual or low intensity behaviors such as walking (Sallis & Hovell, 1990).

Chapter 5: Study III

According to the internalization-automatization hypothesis, self-determined motivation may be internalized to the point that regulation becomes automatic. That is, over time, an explicit, conscious motive can come to operate in an implicit, efficient, and effortless fashion (Legault et al., 2009). Associative environmental cues can unconsciously activate goal pursuit and go on to influence intentions and behavior. In fact, recent research indicated that some types of motivation can be activated merely by associated cues (Ratelle, Baldwin, & Vallerand, 2005). Consequently, one can imagine that the participant's identified motivation may become activated simply by the sight of a stair (opposed to the elevator), and this may occur even when she is tired, distracted, or facing other demands on conscious attention, since little effort is required for such activation. When being physically active is habitual or automatic, people are likely to say that, for them, daily physical activity is part of their life and integrated with their values and life.

Given these internalization-automatization studies, and the suggestion that lifestyle physical activity represents a more habitual, automatic behavior, the present study's results may not preclude the hypothesis that identified regulation plays an important role in this behavior and that the intervention may have worked in the promotion of lifestyle physical activity through the internalization-automatization of identified regulation. In fact, this mechanism may still hold true but was not captured by the explicit nature of our measures (the Burton et al (2006) study was performed with implicit measures). The intervention curriculum (see Silva et al., 2008) was designed to foster the internalization of regulations for exercise, and, although in the case of moderate and vigorous physical activity the intrinsic appeal was stressed, lifestyle physical activity promotion was based on fostering identification, by exploring issues related to the importance of the target activities for the individuals' systems of values.

Limitations

The absence of implicit measures represents a limitation of the present study. Self-determination researchers traditionally measure motivation regulation on an explicit level. If internalizing the importance of a goal leads individuals to construct mental scripts for how to pursue them, the development of implicit measures of self-regulation may add further explanatory power to research based on SDT focusing on sustained adoption of physical activity. Other limitation pertains to the questionnaires used to assess SDT main constructs. This study was part of a larger trial and the definition of the assessments and their protocol of application were already established and could not be changed by the time of these analyses. This led to three assessments-related shortcomings that should be acknowledged. First, relatedness need satisfaction was not addressed in the model because it was not originally included in the assessments battery. When this trial started there was a relative lack of systematic instrument development to assess Basic Needs Theory's constructs specific to exercise setting; consequently, we focused primarily on autonomy and competence (derived from other scales, as described in the methods section). A second limitation is the absence of a measure of integrated regulation, due to the fact that the SRQ-E does not include such a subscale. One last consideration concerns the lack of baseline assessments for exercise and treatment-related outcomes, an option which is justified in the "Methods" section.

It is also important to acknowledge that the steps taken to ensure that interventionists uniformly delivered treatment following SDT principles were not sufficient to consider that fidelity was assessed in a systematic way. Lastly, it should be considered that all participants who entered the study were seeking to lose weight. In that sense, they were all already motivated (to lose weight, not necessarily to perform exercise or to alter dietary patterns) and may not adequately represent the entire population who desires weight loss. Amotivated individuals should also be

investigated, possibly with a separate research design aimed at raising intention to begin addressing body weight problems.

Summary and Future Directions

Notwithstanding these limitations, a distinctive contribution of the present study was the incorporation of lifestyle physical activity and moderate plus vigorous physical activity as separate outcomes to be predicted in the context of obesity treatment, while testing a mediational model aimed at outlining theory-based mechanisms. Convergent with previous research, but extending it into the context of a randomized controlled trial, our model indicates that both psychological needs (for autonomy and competence) and intrinsic motivation mediate the effects of the experimental treatment climate on exercise behavior, at least on its structured form. Results indicate that providing support for autonomy, structure, and involvement will encourage individuals to develop more autonomous regulations, setting the ground to the discovery of personal meaning and enjoyment of exercise. By enhancing our understanding of the mechanisms by which an intervention works in promoting targeted outcomes, and allowing experimental testing of key relationships in a controlled fashion prior to their application in real settings, results from this and other randomized controlled trials can provide ways to develop and implement intervention programs that enhance autonomous motivation and significantly contribute to the development of more cost-effective interventions. A next step in validating the effectiveness of SDT based-interventions will be to explore these associations in the long-term (i.e., over several years), searching for a more in-depth understanding of the dynamics of motivation while providing further information regarding their interrelationships with more enduring dependent variables (e.g., long-term adherence, well-being). Future research should also consider the inclusion of measures of integrated regulation as a predictor of lifestyle physical activity, particularly given the suggestion in the present results that physical activity which

Chapter 5: Study III

proceeds automatically is likely to be described by individuals as part of their lives and as having been well-integrated with their values. Indeed, integration is the process through which individuals fully transform their identified values and behaviors into the self. The process of bringing new ways of thinking, feeling, and behaving in congruence with the self's pre-existing ways could involve some degree of self-examination. For example, exercisers who incorporate the role of being physically active into their identity would act reflectively in accordance with this role and engage in exercise-related activities to reinforce this aspect of their self-concept. Furthermore, to more accurately examine the possibility of automatic processes in self-regulation, the development of implicit measures of motivation is warranted.

REFERENCES

Abu-Omar, K., Rutten, A., & Robine, J. M. (2004). Self-rated health and physical activity in the European Union. *Preventive Medicine, 49*(4), 235-242.

Andersen, R. E., Wadden, T. A., Bartlett, S. J., Zemel, B., Verde, T. J., & Franckowiak, S. C. (1999). Effects of lifestyle activity vs structured aerobic exercise in obese women: a randomized trial. *Jama, 281*(4), 335-340.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology Bulletin, 51*, 1173-1182.

Blair, S. N., Haskell, W. L., Ho, P., Paffenbarger, R. S., Jr., Vranizan, K. M., Farquhar, J. W., et al. (1985). Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *American Journal of Epidemiology, 122*(5), 794-804.

Burton, K., Lydon, J., D'Alessandro, D., & Koestner, R. (2006). The Differential Effects of Intrinsic and Identified Motivation on Well-Being and Performance: Prospective, Experimental, and Implicit Approaches to Self-Determination Theory. *Journal of Personality and Social Psychology, 91*(4), 750-762.

Chapter 5: Study III

Chin, W. W. (1998). The partial least squares approach for structural equation modeling. In G. A. Marcoulides (Ed.), *Modern methods for business research* (pp. 295-336). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chin, W. W., & Newsted, P. (1999). Structural equation modeling analysis with small samples using partial least squares. In R. H. Hoyle (Ed.), *Statistical strategies for small sample research* (pp. 307- 341). Thousand Oaks, CA: Sage.

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Deci, E., & Ryan, R. (2000). The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, 11(4), 227–268.

Deci, E., & Ryan, R. (2008). Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health. *Canadian Psychology*, 49(3), 182–185.

Donnelly, J. E., Blair, S. N., Jakicic, J. M., Manore, M. M., Rankin, J. W., & Smith, B. K. (2009). American College of Sports Medicine Position Stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Medicine and Science in Sports and Exercise*, 41(2), 459-471.

Dunn, A. L., Marcus, B. H., Kampert, J. B., Garcia, M. E., Kohl, H. W., 3rd, & Blair, S. N. (1999). Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial. *Jama*, 281(4), 327-334.

Edmunds, J., Ntoumanis, N., & Duda, J. (2006). A test of selfdetermination theory in exercise domain. *Journal of Applied Social Psychology*, 36, 2240-2265.

Edmunds, J., Ntoumanis, N., & Duda, J. (2007). Adherence and well-being in overweight and obese patients referred to an exercise on prescription scheme: A Self-Determination Theory perspective. *Psychology of Sport and Exercise*, 8, 722-740.

Edmunds, J., Ntoumanis, N., & Duda, J. (2008). Testing a selfdetermination theory-based teaching style intervention in the exercise Domain. *European Journal of Social Psychology*, 38, 375-388.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18, 39-50.

Chapter 5: Study III

Fortier, M. S., Sweet, S. N., O'Sullivan, T. L., & Williams, G. (2007). A self-determination process model of physical activity adoption in the context of a randomized controlled trial. *Psychology of Sport and Exercise*, 8, 741-757.

Guay, F., Boggiano, A., & Vallerand, R. (2001). Autonomy Support, Intrinsic Motivation, and Perceived Competence: Conceptual and Empirical Linkages. *Society for Personality and Social Psychology*, 27(6), 643-650.

Hagger, M., Chatzisarantis, N., & Biddle, S. (2002). The influence of autonomous and controlling motives on physical activity intentions within the Theory of Planned Behaviour. *British Journal of Health Psychology*, 7(Part 3), 283-297.

Hagger, M., & Chatzisarantis, N. (2008). Self-determination theory and the psychology of exercise. *International Review of Sport and Exercise Psychology*, 1, 79-103.

Hayden-Wade, H. A., Coleman, K. J., Sallis, J. F., & Armstrong, C. (2003). Validation of the telephone and in-person interview versions of the 7-day PAR. *Medicine & Science in Sports & Exercise*, 35(5), 801-809.

Hulland J. Use of partial least squares (pls) in strategic management research: A review of four recent studies. *Strategic Management Journal* 1999;20:195-204.

Ingledeu, D., & Markland, D. (2008). The role of motives in exercise participation. *Psychology and Health*, 23(7), 807 - 828.

Ingledeu, D., Markland, D., & Ferguson, E. (2009). Three levels of exercise motivation. *Applied Psychology: Health and well-Being*, 1, 336-355.

Koestner, R., & Losier, G. F. (2002). Distinguishing three ways of being highly motivated: A closer look at introjection, identification, and intrinsic motivation. In E. Deci & R. Ryan (Eds.), *Handbook of self-determination research* (Vol. 101-121). Rochester, NY: University of Rochester Press.

Kraemer, H. C., Wilson, G. T., Fairburn, C. G., & Agras, W. S. (2002). Mediators and moderators of treatment effects in randomized clinical trials. *Archives of General Psychiatry*, 59(10), 877-883.

Legault, L., Green-Demers, I., & Eadie, A. L. (2009). When internalization leads to automatization: The role of self-determination in automatic stereotype suppression and implicit prejudice regulation. *Motivation and Emotion*, 33, 10-24.

Chapter 5: Study III

Levesque C, Copeland K, Sutcliffe R. Conscious and nonconscious processes: Implications for self-determination theory. *Canadian Psychology* 2008;49(3):218-224.

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: distribution of the product and resampling methods. *Multivariate Behavioral Research*, 39, 99-128.

Markland, D., & Hardy, L. (1997). On the factorial and construct validity of the Intrinsic Motivation Inventory: conceptual and operational concerns. *Research Quarterly for Exercise and Sport*, 68(1), 20-32.

Markland, D., & Tobin, V. (2004). A Modification to the Behavioural Regulation in Exercise Questionnaire to Include an Assessment of Amotivation. *Journal of Sport & Exercise Psychology*, 26, 191-196.

Markland, D., Ryan, R., Tobin, V., & Rollnick, S. (2005). Motivational Interviewing and self-Determination Theory. *Journal of Social and Clinical Psychology*, 24(6), 811-831.

Markland, D., & Tobin, V. (2010). Need support and behavioural regulations for exercise among exercise referral scheme clients: The mediating role of psychological need satisfaction. *Psychology of Sport and Exercise*, 11, 91-99.

McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: a confirmatory factor analysis. *Research Quarterly in Exercise & Sport*, 60(1), 48-58.

Murphy, R., Cooper, Z., Hollon, S. D., & Fairburn, C. G. (2009). How do psychological treatments work? Investigating mediators of change. *Behaviour Research and Therapy*, 47(1), 1-5.

Niemiec, C. P., Lynch, M. F., Vansteenkiste, M., Bernstein, J., Deci, E. L., & Ryan, R. M. (2006). The antecedents and consequences of autonomous self-regulation for college: A self-determination theory perspective on socialization. *Journal of Adolescence*, 29, 761-775.

Pelletier, L. G., Fortier, M. S., Vallerand, R. J., & Briere, N. M. (2001). Associations Among Perceived Autonomy Support, Forms of Self-Regulation, and Persistence: A Prospective Study. *Motivation and Emotion*, 25(4), 279-306.

Powers, T., Koestner, R., & Gorin, A. (2008). Autonomy Support From Family and Friends and Weight Loss in College Women. *Families, Systems, & Health*, 26(4), 404-416.

Chapter 5: Study III

Ratelle, C., Baldwin, M., & Vallerand, R. (2005). On the cued activation of situational motivation. *Journal of Experimental Social Psychology, 41*, 482-487.

Reeve, J. (2002). Self-determination theory applied to educational settings. In E. Deci & R. Ryan (Eds.), *Handbook of self-determination research* (pp. 161-182). Rochester: University of Rochester press.

Ringle, Wende, & Will. (2006). SmartPLS (Version 2.0 (beta)). Hamburg, Germany: University of Hamburg.

Ryan, R., & Connell. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and social Psychology, 57*, 749-761.

Ryan, R., Frederick, C., Lepas, D., Rubio, N., & Sheldon, K. (1997). Intrinsic Motivation and Exercise Adherence. *International Journal of Psychology, 28*, 335-354.

Ryan, R., & Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55*(1), 68-78.

Ryan, R., & Deci, E. (2002). An overview of self-determination theory. In E. Deci & R. Ryan (Eds.), *Handbook of self-determination research* (pp. 3-33). Rochester, NY: University of Rochester Press.

Sallis, J. F., & Hovell, M. F. (1990). Determinants of exercise behavior. *Exercise and Sports Science Reviews, 18*, 307-327.

Schafer, J. L., & Graham, J. W. (2002). Missing data: our view of the state of the art. *Psychological Methods, 7*(2), 147-177.

Sheldon, G., Williams, G., & Joiner, T. (2003). *Self-determination theory in the clinic: motivating physical and mental health*. New Haven: Yale University Press.

Shrout, P. E., & Bolger, N. (2002). Psychological Methods. *Mediation in experimental and nonexperimental studies: New procedures and recommendations, 7*, 422-445.

Silva, M. N., Markland, D., Minderico, C. S., Vieira, P. N., Castro, M. M., Coutinho, S. R., et al. (2008). A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: rationale and intervention description. *BMC Public Health, 8*, 234.

Chapter 5: Study III

Silva, M. N., Vieira, P. N., Coutinho, S. R., Minderico, C. S., Matos, M. G., Sardinha, L. B., et al. (2010). Using self-determination theory to promote physical activity and weight control: a randomized controlled trial in women. *Journal of Behavioral Medicine*, 33(2), 110-122.

Teixeira, P. J., Going, S. B., Houtkooper, L. B., Cussler, E. C., Metcalfe, L. L., Blew, R. M., et al. (2006). Exercise motivation, eating, and body image variables as predictors of weight control. *Medicine and Science Sports Exercise*, 38(1), 179-188.

Teixeira, P. J., Silva, M. N., Coutinho, S. R., Palmeira, A. L., Mata, J., Vieira, P. N., et al. (2009). Mediators of Weight Loss and Weight Loss Maintenance in Middle-aged Women. 18, 725-735

USDHHS. (2008). *Physical Activity Guidelines Advisory Committee Report, 2008*. Washington, DC: U.S.: Department of Health and Human Services.

Varo, J. J., Martinez-Gonzalez, M. A., De Irala-Estevez, J., Kearney, J., Gibney, M., & Martinez, J. A. (2003). Distribution and determinants of sedentary lifestyles in the European Union. *International Journal of Epidemiology*, 32(1), 138-146.

Washburn, R. A., Jacobsen, D. J., Sonko, B. J., Hill, J. O., & Donnelly, J. E. (2003). The validity of the Stanford Seven-Day Physical Activity Recall in young adults. *Medicine & Science in Sports & Exercise*, 35(8), 1374-1380.

Williams, G. C., Grow, V. M., Freedman, Z. R., Ryan, R., & Deci, E. (1996). Motivational predictors of weight loss and weight-loss maintenance. *Journal of Personal and Social Psychology*, 70(1), 115-126.

Williams, G. C., Gagne, M., Ryan, R., & Deci, E. (2002). Facilitating autonomous motivation for smoking cessation. *Health Psychology*, 21(1), 40-50.

Williams, G. C., McGregor, H. A., Sharp, D., Levesque, C., Kouides, R. W., Ryan, R., et al. (2006). Testing a self-determination theory intervention for motivating tobacco cessation: supporting autonomy and competence in a clinical trial. *Health Psychology*, 25(1), 91-101.

Wilson, P., & Rodgers, W. (2003). The relationship between perceived autonomy support exercise regulations and behavioural intentions in women. *Psychology of Sport and Exercise*, 5, 229-242.

Chapter 5: Study III

Wilson, P., Rodgers, W., Fraser, S., & Murray, T. (2004). Relationships between exercise regulations and motivational consequences in university students. *Research Quarterly for Exercise and Sport*, 75(1), 81-91.

Wilson, P., Mack, D., & Grattan, K. (2008). Understanding Motivation for Exercise: A Self-Determination Theory Perspective. *Canadian Psychology*, 49(3).

Wold, H. (1985). Partial least squares. In S. Kotz & N. Johnson (Eds.), *Encyclopedia of statistical sciences* (Vol. 8, pp. 587-589). New York: Wiley.

Footnote

¹This paper is part of a larger study and set within the context of other publications using the same database. Due to the extent, nature, and complexity of the analyses involved, reporting all results from this trial in a single manuscript would be inadequate, severely limiting the amount and depth of what could be reported. Thus, a previous published paper described the intervention in great detail and reported the impact of the intervention on the study's main outcomes (weight, physical activity, and theory-based psychological variables), comparing intermediate (4-month) and final (12-month) results for intervention vs. control groups. Differently, the present paper specifically reports on findings from multiple-level mediation analyses for two different types of physical activity, evaluating by what causal mechanisms behavior might have been affected, in an explicit attempt to test causal pathways proposed by the theory under scrutiny.

CHAPTER 6

Exercise autonomous motivation predicts 3-year weight loss in women⁴

“How does it work?”- Long term

“Longitudinal data allow a researcher to examine many aspects of a mediation model that are unavailable in cross-sectional data, such as whether an effect is stable across time and whether there is evidence for the important conditions of causality, temporal precedence.

Mckinnon et al., 2007, p.604

⁴ Silva, M.N., Markland, D., Carraça, E.V., Vieira, P.N., Coutinho, S.R., Minderico, C.S., Matos, M.G., Sardinha, L.B., Teixeira, P.J. Exercise Autonomous Motivation Predicts 3-Year Weight Loss in Women (*Submitted for publication*).

ABSTRACT

Purpose: This study evaluated exercise-related predictors of successful long-term weight control in women, by analyzing the extent to which sustained exercise participation and self-determination theory (SDT)-based exercise motivation variables mediated the impact of a behavioral weight control intervention on 3-year weight change. **Methods:** Longitudinal randomized controlled trial, consisting of a 1-year SDT-based intervention and a 2-year follow-up with 221 female participants (37.6 ± 7 y; 31.6 ± 4.1 kg/m² BMI). The tested model incorporated experimentally-manipulated perceived need support, motivational regulations, and 2-year exercise adherence as mediators of the intervention's impact on 3-year weight change. Paths were tested using partial least squares (PLS) analysis. Where there were significant intervening paths, tests of mediation were conducted. **Results:** Treatment had significant effects on 1- and 2-year autonomous regulation, 2-year physical activity, and 3-year weight change, fully mediated by the tested paths (effect ratios: 0.10 - 0.61). Moderate and vigorous exercise at 2-year had a significant effect ($p < 0.001$) on weight loss success at 3 years, and partially mediated the effect of treatment on weight change. The 2-year autonomous regulation effects on follow-up weight change were only partially mediated by physical activity (effect ratio 0.42). **Conclusions:** This application of SDT to physical activity and weight management showed that not all types of motivation predict long-term behavioral outcomes, and that sustained moderate and vigorous exercise mediated long-term weight change. It provides strong evidence for a link between experimentally-increased autonomous motivation and exercise, and long-term weight loss maintenance. Results highlight the importance of interventions targeting the internalization of exercise behavioral regulation and making exercise and physical activity positive and meaningful experiences, rather than simply focusing on immediate behavior change, in overweight/obese women.

Key Words: Randomized controlled trial; obesity; mediation; self-determination theory; moderate and vigorous physical activity

This trial is registered at [ClinicalTrials.gov \(NCT00513084\)](https://clinicaltrials.gov/ct2/show/study/NCT00513084).

INTRODUCTION

Lifestyle interventions are the most cost-effective means to reduce risk for a variety of important clinical conditions and represent the first step in the treatment of obesity (26). However, poor maintenance of treatment-induced weight loss remains a major challenge in the management of obesity. While behavioral approaches to the management of obesity are often successful in achieving initial clinically significant weight loss, when the weight reduction programs end the weight lost is generally regained (18). Unhealthy eating and exercise habits resurface within weeks to months of completing treatment and empirical evidence highlights the small average long-term weight change (3-4% of initial weight) (16). This notwithstanding, it should be acknowledged that a large individual variability exists in results from weight loss trials. Thus, focusing on the identification of factors associated with success will enhance the understanding of the most critical mechanisms involved, and should be a research priority (33, 34).

The National Weight Control Registry has provided continuous insight into the process of weight maintenance (39). In over 3500 successful weight loss maintainers, several common themes have emerged, with the expenditure of large amounts of energy in voluntary physical activity as the most consistent. Based on empirical evidence, systematic reviews (e.g. 10, 36) indicate that individuals who perform greater amounts of PA have improved rates of weight loss maintenance. This was also highlighted in the 2009 American College of Sports Medicine

Position Stand on physical activity strategies for weight management, which recommended 200–300 min/week of at least moderate physical activity for long-term weight loss (7). However, despite agreement as to the adequate dose of exercise and physical activity, poor behavioral adherence partially explains sub-optimal results in exercise-based interventions (17), and it remains unclear why only some individuals seeking weight loss are able to adopt and successfully sustain this critical behavior. To date, little attention has been given to the predictors of behavioral maintenance, and even when maintenance is explicitly identified, the promoting mechanisms have not been identified (14, 16). To improve our understanding of behavioral maintenance, studies that monitor people through at least 2 years of follow-up, such as the Project Active trials (9), are needed in overweight and obese people. Furthermore, research on theory-based treatment-induced mediators of behavior change is critical to identify potential causal mechanisms through which interventions operate; randomized controlled trials provide the ideal setting for such work (19).

The conceptual framework provided by self-determination theory (SDT) (6) could be useful in explaining long-term adherence by exploring the dynamics of motivation during the course of behavioral change. Key postulates from SDT are that motivation varies in kind and not just in amount, that internal motivation is energized by having one's psychological needs satisfied, and that there are several forms of regulatory motives varying along a continuum of self-determination, reflecting the extent to which the individual acts with volition rather than feeling pressured to act. Intrinsic regulation, involving a focus on the task itself and yielding energizing emotions such as interest, enjoyment, and challenge, as well as identified regulation, reflecting an acceptance of the personal importance and meaningfulness of one's current pursuits, represent autonomous forms of regulation. External regulation, reflecting participation based on contingencies and external demands, and introjected regulation, which is based on avoiding feelings of guilt and shame, represent controlled forms of regulation.

More autonomous regulation has been shown to predict success in many domains, including exercise (see reference 38 for a review), eating behavior (25), and weight control (32, 37), suggesting that lasting behavior change depends not on complying with demands for change but rather on accepting the regulation for change as one's own. More self-determined forms of behavioral regulation will be promoted to the extent that the basic psychological needs for autonomy (fulfilled when people perceive that they have real choices and are at the origin of their decisions, which they freely endorse), competence (concerning an individual's need to feel a sense of mastery and effectance), and relatedness (concerning having satisfying and supportive social relationships) are met, in a dialectic interaction between the individual and the social environment (6). Thus, social contexts that foster autonomous regulation, by supporting basic needs, will facilitate the internalization and integration of regulatory processes and thus promote more adaptive behaviors and better long-term outcomes (6). Thus, both autonomy-support and autonomous regulation are important for sustained behavior change. Moreover, a recent study (24) suggests that the quality of motivation may be one mechanism through which successful self-regulation in one area may affect ("spill over") into other behavioral domains, suggesting that autonomously-motivated exercise behavior contributes to improved weight control not only through the effects of physical activity itself but also due to spill-over effects on the regulation of other relevant behaviors such as eating.

Despite a growing body of evidence, SDT-based studies have been predominantly cross-sectional (see reference 12 for a review). Consequently, they are restricted in the extent to which they can explain the motivational mechanisms influencing exercise engagement and weight management across time. Longitudinal methodologies are required to examine the internalization process and the role of different regulations over time. Furthermore, despite the relatively well documented role of need-supportive interventions on promoting more autonomous forms of behavioral regulation (see reference 38 for a review), no information

exists on the extent to which such regulatory patterns are maintained after termination of the intervention. In other words, evidence for the efficacy of interventions in causing relatively enduring changes in motivation and self-regulation towards exercise is lacking. In the present study, in the context of a longitudinal RCT, we sought to evaluate predictors of successful long-term weight control by analyzing the extent to which perceived need support, exercise behavioral regulations, and 2-year exercise participation mediated the impact of the intervention on long-term weight control (29, 31). Based on theoretical assumptions and on previous research in exercise motivation and adherence (12, 38), we hypothesized that i) experimentally-manipulated treatment climate would have a positive impact on the development of exercise autonomous regulation up to one year after the intervention's end (2-year), ii) autonomous regulation at intervention's end (1-year) would predict autonomous regulation at 2 years follow-up, iii) 2-year autonomous regulation would mediate the effect of treatment on 2-year exercise, and iv) long-term exercise adherence (2-year) would be associated with weight change at 3 years and partially mediate the effects of exercise regulation at 2 years on weight change. Additionally, based on previous studies (1, 24) we also hypothesize that autonomous regulation for exercise at 2 years would be associated with long-term weight loss independently of actual exercise level, i.e., direct effects would remain significant after the indirect effects of self-reported exercise minutes were accounted for.

METHODS

Study Design and Intervention

The trial consisted of a 1-year behavior change intervention and a 2-year follow-up period with no intervention. The control group received a 29-session general health education curriculum based on several educational courses covering various topics (e.g., preventive

nutrition, stress management, self-care, and effective communication skills). The intervention group attended 30 sessions, targeted at increasing PA and energy expenditure, adopting a diet consistent with a moderate energy deficit, and integrating exercise and eating patterns that would support weight maintenance. The program's principles and style of intervention were based on self-determination theory (6), with a special focus on increasing autonomous regulation toward exercise and weight control. Guiding principles of the intervention included providing participants with adequate structure and a range of options to choose from, supporting their autonomous decisions during the program, and encouraging them to explore their own motivations for treatment and define their personal treatment goals (within the recommended targets), while limiting external contingencies and controls (e.g., outcomes-based rewards or praise, external monitoring of behaviors and body weight). The study was part of a larger longitudinal randomized controlled trial, and set within the context of other publications from the same database which have detailed the study's theoretical rationale and intervention curriculum, and reported 1-year results (29-31). Approval was obtained from the Faculty Ethics Committee and prior to participation all participants gave written informed consent.

Participants

Participants were recruited from the community at large through media advertisements. By design, participants had to be female, between 25–50 years old, premenopausal, have a BMI between 25 and 40 kg/ m², be willing to attend weekly meetings (during 1 year), be free from major illnesses, and not taking medications known to interfere with body weight regulation. A total of 258 women completed initial assessments and were randomized to intervention and comparison groups. Thirty seven women were subsequently excluded from all analyses, because they started taking medication (antidepressant, anxiolytic, and antiepileptic) susceptible to affect weight (n=13) or because of serious chronic disease diagnosis or severe

illness/injury ($n=4$). Others were excluded because of pregnancy ($n=11$) or because they entered menopause ($n=9$). These 37 women were of similar age ($p=0.737$) and BMI ($p=0.852$) as the 221 participants who were considered as the valid initial sample for this study. The effective sample was between 23 and 50 years old (37.6 ± 7 years) and overweight or mildly obese, with an initial BMI of 31.6 ± 4.1 kg/m². There were no differences between this initial sample and women who quit the program for any demographics or psychosocial variables at baseline, with the exception of age; women who stayed in the trial until the 3-year assessments were on average 3 years older ($p=0.05$) at program start. There were also no differences for the same variables between women who completed the 1-year intervention and those who were lost to follow-up at years 2 and 3 (p values >0.05). Reasons for attrition included financial/time limitations ($n=15$), moving to another city ($n=4$), dissatisfaction with group assignment ($n=1$); all other women lost to follow-up did not provide a reason ($n=45$). Thus, 156 women were available for assessments at 3 years: 71% overall retention, 79% in the intervention group. Given the differential attrition rate between the two randomly assigned conditions, we explored if the baseline scores for those who later dropped out were different between conditions and no differences were found (p values >0.05). Furthermore, we also analyzed if, within each condition, baseline scores were different between completers and later dropouts; again, no differences were found within either group of women (p values >0.05).

Measurements

Perceived Need Support

This variable, which concerns the quality of the social/treatment environment, was assessed by the Health Care Climate Questionnaire (HCCQ) (38). SDT posits three aspects of a motivationally-facilitative social environment – autonomy support, structure, and involvement

– which correspond to supporting the satisfaction of the psychological needs for autonomy, competence, and relatedness (Deci & Ryan, 1991). As noted by Markland and Tobin (22) although the HCCQ was designed to assess autonomy-support, it includes items reflecting all three dimensions of the facilitative environment: autonomy support (e.g., “I feel that the staff has provided me choices and options”), structure (e.g., “the staff has made sure I really understand my condition and what I need to do”), and involvement (e.g., “the staff handle peoples’ emotions very well”). The three support dimensions are, however, highly inter-related so their items are typically collapsed into a single score. Responses to the 15 items were rated on a 7-point Likert-type scale ranging from 1=strongly disagree to 7= strongly agree).

Behavioral Regulations of Exercise

The types of regulations for exercising were measured with the Exercise Self-Regulation Questionnaire (SRQ-E) (28). The SRQ-E comprises four subscales assessing four different types of behavioral regulations, defined in terms of the degree to which the regulation of an activity has been internalized and integrated. Participants have to indicate, for each of the 16 items (4 for each subscale), their reasons for exercising on a 7-point Likert-type scale, ranging from 1 (not at all true) to 7 (very true). Examples of items included in different regulations subscales are (in order from the least to the most fully internalized): external regulation (“because I feel like I have no choice about exercising; others make me do it”), introjected regulation (“because I would feel bad about myself if I did not”), identified regulation (“because it feels important to me personally to accomplish this goal”) and intrinsic regulation: (“because it is a challenge to accomplish my goal”, “because it is fun”). Given this study’s focus on examining the role of treatment support for exercise autonomous regulation and sustained exercise participation as mediators of the impact of an intervention on 3-year weight change, autonomous self-regulation was specified as a higher-order reflective latent

variable with identified and intrinsic self-regulations as its lower-order latent indicators. Controlled regulations (external and introjection) were still treated separately because they represent dissimilar constructs with potentially differential consequences for behavioral adherence and well-being (20).

Exercise Behavior

The 7 day Physical Activity Recall (7 Day-PAR) (3) was used to determine the duration and intensity of physical activities. Trained interviewers asked participants to recall time spent doing physical activity for the past 7 days (or a typical week of last month, if the previous week was atypical), guiding the participants through the recall process, day by day. Previous studies have supported the reliability and validity of the 7-Day PAR as a measure of physical activity (13). For the current study, activity reports were collapsed into total minutes of moderate and vigorous intensity physical activity in a week (all activities above 3 METs were considered).

Body Weight

Weight-related measurements were performed in the morning, after fasting for 3 h. Body weight was measured twice, using an electronic scale calibrated onsite and accurate to 0.1 kg (SECA, Hamburg, Germany). Vertex height was measured with a balance-mounted/stadiometer to the nearest 0.1 cm. Body mass index (BMI) in kilograms per squared meter was calculated from weight (kg) and height (m). Weight outcomes were expressed as percent weight change from baseline (16).

Statistics and Data Analysis

Preliminary analyses, group differences, and comparison of individuals with and without missing data were conducted using PASW statistics/ SPSS 18.0. Descriptive results are expressed in terms of group means \pm SD, and between-group differences were explored using

t-tests for independent samples. Model testing was conducted using partial least squares (PLS) analysis with the SmartPLS Version 2.0 (M3) software (27). PLS is a structural equation modeling approach that uses a least-squares estimation procedure. It was used in the present study for two reasons. First, PLS is a non-parametric method which makes no restrictive assumptions about the distributions of the data, unlike the covariance-based structural equation modeling approach (e.g., LISREL) (4). Second, while covariance-based modeling requires a large number of cases relative to the number of parameters in the model to be estimated, PLS is ideally suited for use with smaller sample sizes (5) due to the partial nature of the estimation procedure, with only one part of the model being estimated at each time. Furthermore, by using an iterative estimation method that minimizes residual variance by providing successive approximations for the estimates of loadings and path parameters, PLS allows that the resulting component score for each latent variable is based on the best estimated indicator weights; consequently it maximizes the variance explained for the dependent variables (i.e., latent, observed, or both).

The model tested in the present study, using a prospective 3-wave design (Figure 1), incorporates randomization condition (coded as control-0 and treatment-1 groups), perceived need support and forms of exercise self-regulation (autonomous, introjected and external regulation) at time 1 (1-year intervention's end), exercise self-regulation and moderate and vigorous exercise at time 2 (2-year follow-up), and weight-change at time 3 (3-year follow-up). There is a path between each self-regulation variable assessed at Time 1 (1-year) and Time 2 (2-year). And there are also direct paths between 2-year self-regulations and 3-year weight change. For the PLS analyses, listwise deletion of missing data was implemented and only participants with all data points for all variables in the model are included. With models comprising only reflective latent variables, the recommended minimum sample size is ten times the number of structural paths leading to the endogenous latent variable with the largest

number of such paths (5). For the present model, this amounted to three paths, and a minimum sample size of 30, which was far exceeded with the current data.

The PLS model was analyzed in two stages, following the recommendations of Fornell & Larcker (11). In the first stage, the measurement model was tested including: (i) estimation of individual item reliabilities by inspecting the loadings of the items on their respective latent variables. For reliability of an indicator, the standardised loading of the indicator on its intended latent variable should be statistically significant and higher than .40 (11); (ii) assessment of the latent variables' internal consistency by examining their composite reliabilities (CR). CR is considered superior to Cronbach's alpha reliability coefficient, providing a better estimate of variance shared by a set of indicators because the former does not assume equal weightings of items (a CR of .70 or higher represents acceptable internal consistency); (iii) evaluation of discriminant validity of the scales by examining the average variance extracted (AVE) for the scales. The AVE is the average amount of variance in a set of indicators explained by their latent variable. Regarding convergent validity, the AVE should be at least .50 (i.e., the latent variable explains on average 50% or more of the variance in its indicators). Regarding discriminant validity of the latent variables, the average variance shared between a latent variable and its indicators should be greater than the variance shared between the variable and other latent variables in the model.

In the second stage, the structural model was tested. Autonomous self-regulation was specified as a higher-order reflective latent variable with identified and intrinsic self-regulations (with their respective indicators from the SRQ-E) as its lower-order latent indicators. All other latent variables were also specified as reflective (perceived need support with the items from HCCQ, external and introjected self-regulations with the respective items from SRQ-E). The standardised path coefficients (β) and the variance explained in the endogenous variables (R^2) were examined. Since SmartPLS does not generate significance

tests for the variance explained in the dependent latent variables, effect sizes of the R^2 values were calculated (5, 15): Cohen's $f^2 = R^2/(1 - R^2)$. Effect sizes of .02, .15, and .35 are considered small, medium, and large, respectively (6). Regarding the standardized path coefficients (β), SmartPLS implements a bootstrapping procedure to estimate means and standard errors for the estimates which can then be tested for significance by the t -statistic (note: because bootstrap procedures do not assume normality of the distribution, they provide stronger protection against type II error). In order to assess mediated effects, bootstrapped estimates and standard errors were obtained for indirect effects where there were significant intervening paths between distal variables. In addition, where there were significant indirect effects we report the ratio of the indirect effects to the direct effects. The effect ratio indicates the strength of mediation effects and is a preferable (quantitative) way to describe mediated effects, overcoming the full/partial mediation dichotomous distinction (30).

Weight outcomes were expressed as percent weight change from baseline. For putative mediators absolute scores were used instead of change from baseline. This choice was based on the fact that perceived need support ("I feel that the staff has...") and exercise self-regulation (e.g., "I exercise because I" . . .) variables were not assessed at baseline given that most participants did not engage in regular exercise at the beginning of the intervention. For consistency, we decided to also use physical activity measures at 2 years, instead of change in physical activity. Because this sample was mostly sedentary at baseline, the outcome measure was considered to represent well the result of the intervention on this variable. Nevertheless, we compared baseline scores between intervention and controls for general self-determination variables and for exercise minutes, and no differences were found ($p>0.05$).

RESULTS

At 1-year (intervention's end), the intervention group showed greater weight loss ($-7.3 \pm 5.9\%$ of initial body weight) and higher levels of moderate plus vigorous exercise (300 ± 179 min/wk) than participants in the control group ($-1.7 \pm 5.0\%$; 162 ± 171 min/wk, $p < 0.001$). Furthermore, group differences for the main psychosocial intervention targets were medium to large (d ranged between 0.45 and 1.35) favoring the intervention group (all $p < 0.001$), including perceived need support and autonomous regulation (note: for detailed 1-year results see Silva et al., 2009). At 2-years (first year of follow-up), the intervention group showed higher levels of exercise (272 ± 223 min/week vs. 179 ± 174 min/week in the control group, $p = 0.009$), higher weight loss ($-5.5 \pm 7.7\%$ vs. $-2.2 \pm 7.5\%$, $p = 0.004$) and higher scores on the exercise self-regulatory variables: external regulation ($d = 0.40$, $p = 0.020$), introjected regulation ($d = 0.56$, $p < 0.001$), and autonomous regulation ($d = 0.44$, $p < 0.001$). At 3-years (second year of follow-up), percent weight change from baseline remained significantly higher in the intervention group ($-3.9 \pm 7.6\%$ vs. $-1.9 \pm 7.4\%$) than the control group, $p = 0.040$, and also higher levels of exercise (234.1 ± 221 min/week vs. 148.1 ± 163 min/week in the control group, $p = 0.009$). Following intention-to-treat principles (ITT) and including all starting subjects in statistical analysis, we used baseline imputation for all dropouts. Whether or not ITT was adopted had no effect on the study inferences (differences between the two groups remained highly statistically significant).

Testing of the Measurement Model

Initial analysis showed that two observed indicators (one for perceived need support and one for introjected regulation) had very low factor loadings and that the AVEs with these indicators included were below the acceptable level. Thus, these items were eliminated and

the model re-estimated. Subsequent PLS and bootstrapped estimates for all factor loadings were greater than 0.40 and significantly greater than zero in all cases. **Table 1** show the CRs, AVEs, and correlations among the variables in the model. CRs were all greater than 0.70 and AVEs were greater than 0.50, indicating acceptable convergent validity for the items. AVEs for each latent variable were greater than the squared bivariate correlations with all the other latent variables, indicating acceptable discriminant validity. Correlation coefficients matched expected patterns of association. Treatment and perceived need support were significantly correlated with autonomous regulation for exercise both at 1 and 2 years, and also with weight loss at 3 years. Autonomous regulation, both at 1 and 2 years was correlated with exercise at 2 years and weight loss at 3 years. External regulation did not show associations with exercise and weight related variables (nor with autonomous regulation). Although 1-year introjected regulation was not correlated with exercise, at 2-year a significant association emerged. Taken together, these findings suggest that the measurement model was satisfactory.

Testing of the Structural Model:

Figure 1 shows the PLS and bootstrapped parameter estimates for the structural paths included in the model, and the variance accounted for in the dependent variables (R^2). With the exception of the effects of perceived need support on external and introjected regulations and of these regulations on exercise and weight loss, all hypothesized paths were significant. The model explained between 2% and 46% of the variance in the dependent variables.

Table 1

Composite Reliability (CR), Average Variance Extracted (AVE) and Correlations of Factors in the Measurement Model

Factor	CR	AVE	Correlations															
			1	2	3	4	5	6	7	8	9	10						
1. Treatment (Intervention vs. control group)	—	—	—															
2. Perceived Need Support (1-year)	0.97	0.68	0.44 ***	—														
3. External Self-Regulation (1-year)	0.85	0.58	-0.04	-0.14	—													
4. Introjected Self-Regulation (1-year)	0.79	0.56	0.32 ***	0.15	0.27 ***	—												
5. Autonomous Self-Regulation (1-year)	0.95	0.68	0.44 ***	0.46 ***	-0.17 *	0.35 ***	—											
6. External Self-Regulation (2-year)	0.86	0.60	0.15	0.05	0.50 ***	0.17 *	0.05	—										
7. Introjected Self-Regulation (2-year)	0.84	0.64	0.32 ***	0.12	0.07	0.55 ***	0.28 ***	0.31 ***	—									
8. Autonomous Self-Regulation (2-year)	0.95	0.69	0.23 **	0.29 ***	-0.25 **	0.23 **	0.68 ***	0.02	0.39 ***	—								
9. Moderate & Vigorous Exercise (2-year)	—	—	0.22 **	0.09	-0.07	0.13	0.27 ***	0.09	0.30 ***	0.41 ***	—							
10. Weight Change % (3-year)	—	—	-0.17 *	-0.16 *	0.12	0.03	-0.23 **	-0.08	0.00	-0.25 **	-0.32 ***	—						

Note. N = 135

*p<0.05, **p < 0.01, ***p <0.001.

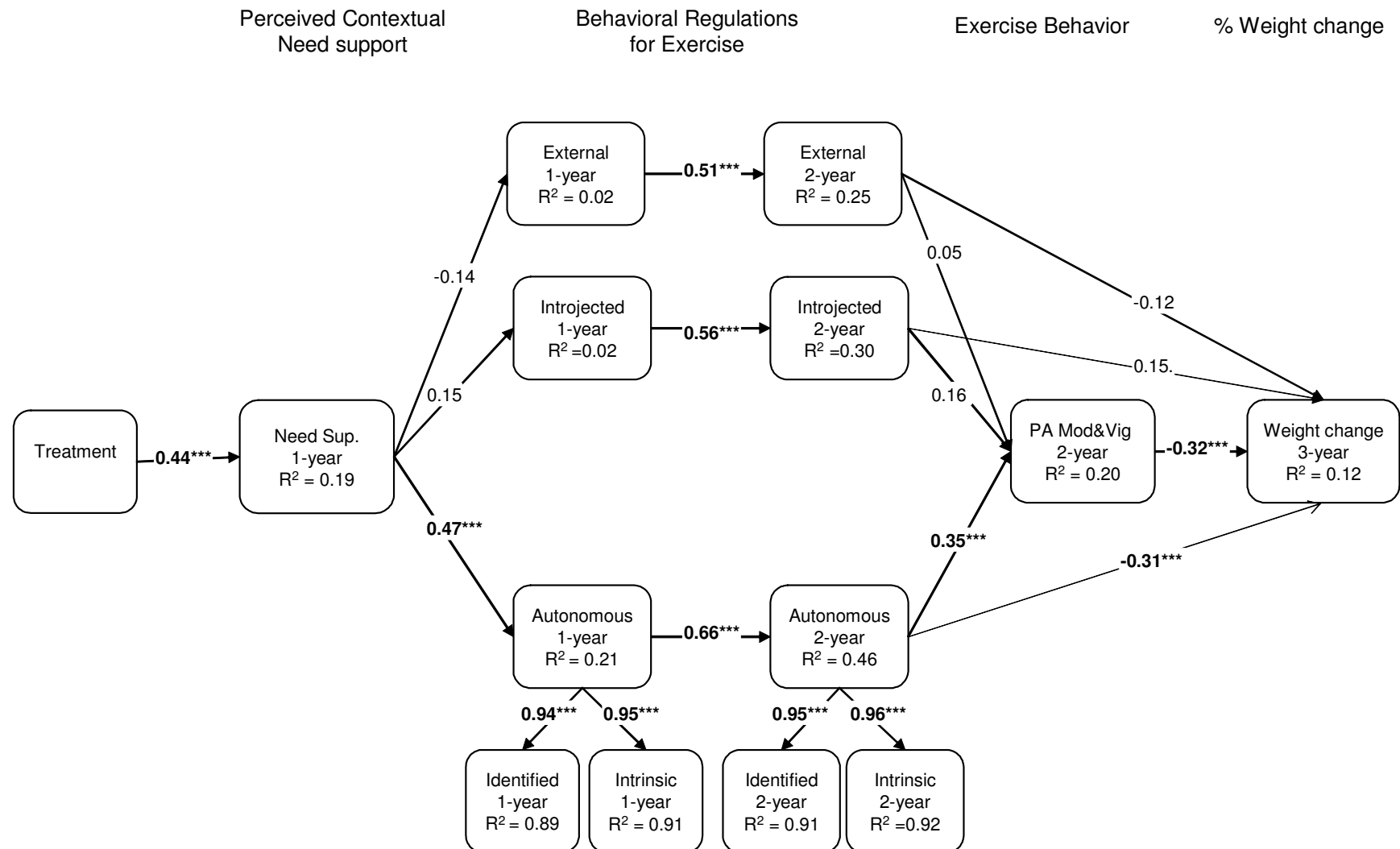


Figure 1. Structural model with parameter estimates. Values in the Paths represent the standardized bootstrap estimate for direct effects, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. To enhance clarity of the figure, the indicators and item uniqueness are not reported.

Table 2 shows the bootstrapped estimates and standard errors for indirect effects and the effect ratios. Treatment had significant indirect effects on 1-year and 2-year autonomous self-regulation, 2-year exercise, and 3-year weight change. The effect of treatment on 1-year autonomous regulation was partially mediated by perceived need support (effect ratio of 0.46). For 2-year autonomous self-regulation, the effect of treatment was partially mediated by both need support and 1-year autonomous self-regulation, with 61% of the total effect being explained by these indirect paths. The effect of treatment on 2-year exercise and on 3-year weight loss was partially mediated by the same paths (effect ratios of 0.24 and 0.10 respectively).

Perceived need support effects on 2-year autonomous self-regulation were mediated by 1-year autonomous self-regulation, and on exercise at 2 years mediated by 1 and 2-year autonomous regulation (both effect ratios of 1.0). Perceived need support also had significant effects on 3-year weight change, partially mediated by autonomous self-regulations and exercise (effect ratio 0.22). One-year autonomous self-regulation effects on 2-year exercise were largely mediated by 2-year autonomous self-regulation (effect ratio 0.81), and effects on 3-year weight change were partially mediated by both 2-year autonomous self-regulation and exercise (effect ratio 0.33). Finally, the 2-year autonomous self-regulation effects on 3-year weight change were partially mediated by exercise, with 42% of the total effect being explained by this particular indirect path.

Table 2

Structural Model Indirect Effects for Mediation Tests and Effect Ratios

<i>From</i>	<i>To</i>	<i>Estimate</i>	<i>Standard error</i>	<i>Effect Ratio</i>
Treatment (Intervention vs. control group)	Autonomous Self-Regulation (1-year)	0.21	0.05 ***	0.46
Treatment (Intervention vs. control group)	Autonomous Self-Regulation (2-year)	0.14	0.04 ***	0.61
Treatment (Intervention vs. control group)	Moderate & Vigorous Exercise (2-year)	0.05	0.01 ***	0.24
Treatment (Intervention vs. control group)	Weight Change % (3-year)	-0.02	0.01 *	0.10
Perceived Need Support (1-year)	Autonomous Self-Regulation (2-year)	0.33	0.06 ***	1.00
Perceived Need Support (1-year)	Moderate & Vigorous Exercise (2-year)	0.12	0.03 ***	1.00
Perceived Need Support (1-year)	Weight Change % (3-year)	-0.04	0.01 **	0.22
Autonomous Self-Regulation (1-year)	Moderate & Vigorous Exercise (2-year)	0.24	0.05 ***	0.86
Autonomous Self-Regulation (1-year)	Weight Change % (3-year)	-0.08	0.03 ***	0.33
Autonomous Self-Regulation (2-year)	Weight Change % (3-year)	-0.11	0.04 ***	0.42

Note. N = 135; Estimates derived from 5000 bootstrap samples.

*p < 0.05, **p < 0.01, ***p < 0.001.

DISCUSSION

The primary purpose of this study was to evaluate predictors of successful long-term weight control in overweight and obese women, by analyzing the extent to which sustained exercise participation and theory-based psychosocial variables related to exercise motivation mediated the impact of a behavioral intervention on 3-year weight change. This is a relevant research target considering the well-established need to identify predictors of sustained weight loss and lifestyle change over time, in this population. Despite consistent evidence that individuals who exercise regularly tend to maintain their weight loss (10, 36), mechanisms regulating behaviors as widely prescribed as exercise and physical activity need to be more thoroughly understood and extensively tested. For its role in energizing the direction and persistence of human behavior, motivation is clearly among the best candidates for predicting exercise participation, including among the overweight and obese (12). In this study, we show that not all types of motivation predict long-term behavioral outcomes and that autonomous regulations are the critical intermediate mechanisms. Also, we describe the extent to which 2-year moderate and vigorous exercise mediates 3-year weight loss and maintenance. To our knowledge, both findings are novel in the area of exercise adherence in overweight and obese people.

As hypothesized, long-term exercise participation had a significant effect on weight loss success at 3 years, and partially mediated the effect of treatment on weight change. These results support and expand previous retrospective, cross-sectional, and prospective observational studies, highlighting the critical role of exercise in weight loss maintenance (15, 39). The present results clearly indicate that, in the context of a comprehensive behavioral intervention (also including a nutrition and eating behavior component), overweight and obese women who increase and sustain their physical activity over time will benefit in terms of their long-lasting ability to manage body weight. We are unaware of previous studies which have

reported 3-year weight outcomes as a function of increases in exercise induced by a controlled intervention. Jakicic (15) has also demonstrated that when 12-month data were analyzed based on the amount of exercise actually performed, greater levels of exercise were associated with a greater magnitude of weight loss after a 12-month treatment.

The most critical pathways by which exercise contributes to safe and effective obesity treatment are still under investigation. The most important physiological mechanisms include direct increases in energy expenditure, promotion of fat oxidation and fat tissue loss, and attenuation of the weight loss-induced decline in resting energy expenditure (10). Increasingly, researchers are also highlighting the role of psychological mechanisms associated with regular exercise participation, specifically in the overweight and obese population (e.g., improved well-being and self-esteem, reduced anxiety and depression, and also enhanced self-regulatory skills). These could also effect long-term weight control, for example by their effect on compliance with dietary changes (2, 23). In the present study, we found evidence of similar mechanisms, by showing that the effects of autonomous regulation on 3-year weight change was only partially mediated by physical activity, with 42% of the total effect being explained by this particular indirect path; the remaining effects of exercise motivation presumably affected weight through alternative pathways. For instance, a recent study indicated the possibility of “spill-over” effects in self-regulation, showing that increased general self-determination and exercise motivation facilitated improvements in eating self-regulation during weight control in women (24). Certain types of regulations/motivational styles may also be more associated than others with psychological well-being, for instance at the emotional and self-perception levels (6). These aspects are often ignored in the behavior change literature, specifically in obesity studies, but there are suggestions that, for example, improved self-worth and body image can also benefit weight control (32) and are also associated with more internal exercise motivation (21). There may, in fact, be an intricate

interplay between physiology and psychology regarding the effects of exercise on sustained weight loss. However, this interplay only applies if the exercise is actually performed, which has led some researchers (e.g. 10) to conclude that low adherence largely explains the mixed results for the role of exercise in weight control. Our results are supportive of this assertion in a sample of overweight and obese women.

Considerable research has been conducted to identify factors connected with long-term exercise adherence (see 35 for a review). However, as most of the work in this field relies on cross-sectional studies, longitudinal and intervention research is required if causal relationships are to be inferred (12). Furthermore, effective testing of theoretical models within an intervention trial requires longitudinal assessment of theoretical constructs, followed by mediation analyses (19). Accordingly, this study tested experimentally-manipulated perceived need support and motivational regulations as mediators of the intervention's impact on long-term exercise adherence and weight loss. We chose SDT because this framework is at the forefront of research examining the psychological antecedents, mechanisms, and basis for intervention in exercise contexts (12, 38).

The degree to which participants experienced the staff as need supportive was a significant mediator of autonomous reasons for engaging in exercise one year after the intervention ended, something which has not been reported before. This is of great practical significance because it suggests that the interpersonal climate created by the health-care staff in a weight loss program can influence the long-term autonomy of participants' motivation for being physically active. Additionally, the finding that the 1-year autonomous regulation effects on 2-year exercise were fully mediated by 2-year autonomous regulation (effect ratio 0.81) support the a priori mechanistic explanation for long-term exercise adherence; self-motivation can become more critical over time as continued behavioral changes require overcoming new obstacles, persisting through difficult times, and sustaining action when the initial impetus and

reinforcers associated with the intervention are no longer available (as in the case of a follow-up period). From an SDT perspective, the internalization process (integration within the self of the behavioral motivational regulation) can explain these findings (6). Autonomous motivation implies proactivity, whereby individuals act on the environment to exert some control over it. Thus, even in the absence of the intervention's autonomy-supportive context, more autonomously motivated participants may have managed to stay on course by actively transforming their exercise environment (because they internalized the means to do it). Furthermore, only autonomous motivation was a mediator of the effect of treatment on 2-year exercise outcomes and on 3-year weight loss. As hypothesized, the mediation paths through introjected and especially external regulations were small and failed to attain statistical significance. According to SDT, even when controlled regulations act as catalysts of short-term changes, only more autonomous motivation is associated with enhanced maintenance of behavior change. In previous studies, increases in intrinsic exercise motivation during treatment explained some of the long-term effects of a behavioral intervention on weight control (34), in one case above and beyond short-term changes in weight and eating-related variables (32).

This study is not without limitations. It only included overweight and obese women, and therefore it is unclear whether similar results would be observed in men. Exercise was measured using a self-report questionnaire that has been shown to provide a valid and reliable assessment of physical activity. However, future studies may consider incorporating objective measures of physical activity such as accelerometry and HR monitors. Furthermore, this study only considered moderate and vigorous exercise. Other forms of physical activity could also be considered to explain the intervention effects on weight control. Another limitation concerns the lack of assessments of exercise behavioral regulations at baseline (an option justified in the Methods section). Despite the fact that there were no differences regarding

demographic and more general SDT variables, the possibility that groups differed at baseline cannot be entirely ruled out.

Practical Implications

Considering the importance of exercise in successful long-term obesity treatment, understanding the mechanisms behind the development of autonomous regulation, widely viewed as a predictor of continued behavioral adherence, is an important topic for conceptual and practical reasons, namely to develop more effective exercise promotion interventions and practices. Although in many studies exercise has been an element of treatment, the main focus was weight loss or body composition change and only the physiological elements of the exercise program were described (e.g. 8). Conversely, description of the finer details of program delivery (as they are likely to have a major influence on successful adoption and long-term adherence), and especially of the psychological mechanisms underlying successful behavior change are scarce in literature. While some studies have examined post-hoc associations between exercise and weight loss maintenance (e.g. 15) and others focused on the effect of motivational constructs on exercise behavior and/or weight change (32, 34, 37), this study examined both these elements in an integrated longitudinal model, within the context of a randomized controlled trial. The results of this study with overweight and obese women may have implications for future interventions by highlighting the importance of an increased focus on making exercise a positive and meaningful experience rather than simply attempting to change behavior. External (or introjected) contingencies can produce results but they are a short-term solution for a long-term problem. In the general population, research has now consistently shown that maintenance of exercise is especially related to the *process* and the quality of the exercise participation experience, which emphasizes intrinsic or well-integrated motives (12, 38). We have now shown the same applies to overweight and obese women. Thus, health professionals are encouraged to help participants make the transition from

“should” to “want to” motivation. Partially, this means going beyond teaching/training particular behavior change skills (e.g., goal setting, self-monitoring) to encompass strategies like participants’ verbalization of their own behavioral goals, and exploration of how these goals can be accomplished in the context of their lifestyle, identifying factors that encourage more identified and intrinsic reasons for change (while downplaying external reasons to exercise), promoting competence and confidence (e.g. through modeling). Also, and most importantly, the support of autonomy and self-initiation are recommended by assuring choice (e.g., promoting active experimentation, supporting subjects’ initiatives, minimizing external sources of control/pressure), exploring individual values, meanings, and goals and how they can be linked to the targeted behavioral changes, and interpreting and deconstructing social pressures/expectations. In sum, it is important to help overweight and obese women focus on their own valued goals (e.g., health and fitness, improved well-being) as well as behavioral targets (i.e., adopting certain exercises or attending a certain number of sessions per week), and also encourage the creation of enjoyable exercise environments. Fortunately, a wide variety of sports and physical activities are available, and these provide multiple opportunities for optimal challenges and different experiences that can help all people develop the sense of ownership and mastery that underpins autonomous regulation. The challenge is thus on the side of health professionals to effectively target and change the most important mediating mechanisms, while discarding the least effective, for the (long-term) benefit of those who seek their expert guidance.

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CONFLIT OF INTEREST

None to declare. The results of the present study do not constitute endorsement by the American College of Sports Medicine.

REFERENCES

1. Andrade AM, Coutinho SR, Silva MN, et al. The effect of physical activity on weight loss is mediated by eating self-regulation. *Patient Educ Couns* 2010;79(3):320-6.
2. Baker CW, Brownell KD. Physical activity and maintenance of weight loss: Physiological and psychological mechanisms. In: Bouchard C, editor. *Physical activity and obesity*. Champaign, IL: Human Kinetics; 2000. p. 311-328.
3. Blair SN, Haskell WL, Ho P, et al. Assessment of habitual physical activity by a seven-day recall in a community survey and controlled experiments. *Am J Epidemiol* 1985;122(5):794-804.
4. Chin WW. The partial least squares approach for structural equation modeling. In: Marcoulides GA, editor. *Modern methods for business research*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1998. p. 295-336.
5. Chin WW, Newsted P. Structural equation modeling analysis with small samples using partial least squares. In: Hoyle RH, editor. *Statistical strategies for small sample research*. Thousand Oaks, CA: Sage; 1999. p. 307- 341.
6. Deci E, Ryan R. The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychol Inquiry* 2000;11(4):227–268.

7. Donnelly JE, Blair SN, Jakicic JM, Manore MM, Rankin JW, Smith BK. American college of sports medicine position stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. *Med Sci Sports Exerc* 2009;41(2):459-71.
8. Donnelly JE, Hill JO, Jacobsen DJ, et al. Effects of a 16-month randomized controlled exercise trial on body weight and composition in young, overweight men and women: The midwest exercise trial. *Arch Intern Med* 2003;163(11):1343-50.
9. Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW, 3rd, Blair SN. Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: A randomized trial. *Jama* 1999;281(4):327-34.
10. Fogelholm M, Kukkonen-Harjula K. Does physical activity prevent weight gain--a systematic review. *Obes Rev* 2000;1(2):95-111.
11. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. *J Marketing Res* 1981;18:39-50.
12. Hagger M, Chatzisarantis N. Self-determination theory and the psychology of exercise. *Intern Rev Sport Exerc Psychol* 2008;1:79-103.
13. Hayden-Wade HA, Coleman KJ, Sallis JF, Armstrong C. Validation of the telephone and in-person interview versions of the 7-day par. *Med Sci Sport & Exerc* 2003;35(5):801-9.
14. Jakicic JM, Jaramillo SA, Balasubramanyam A, et al. Effect of a lifestyle intervention on change in cardiorespiratory fitness in adults with type 2 diabetes: Results from the look ahead study. *Int J Obes (Lond)* 2009;33(3):305-16.
15. Jakicic JM, Marcus BH, Gallagher KI, Napolitano M, Lang W. Effect of exercise duration and intensity on weight loss in overweight, sedentary women: A randomized trial. *Jama* 2003;290(10):1323-30.

16. Jeffery R, Epstein L, Wilson G, et al. Long term maintenance of weight loss: Current status. *Health Psychol* 2000;1:5-16.
17. King NA, Hopkins M, Caudwell P, Stubbs RJ, Blundell JE. Beneficial effects of exercise: Shifting the focus from body weight to other markers of health. *Br J Sports Med* 2009;43(12):924-7.
18. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 2002;346(6):393-403.
19. Kraemer HC, Wilson GT, Fairburn CG, Agras WS. Mediators and moderators of treatment effects in randomized clinical trials. *Archiv Gen Psych* 2002;59(10):877-83.
20. Levesque CS, Williams GC, Elliot D, Pickering MA, Bodenhamer B, Finley PJ. Validating the theoretical structure of the treatment self-regulation questionnaire (tsrq) across three different health behaviors. *Health Educ Res* 2007;22(5):691-702.
21. Markland D. The mediating role of behavioural regulations in the relationship between perceived body size discrepancies and physical activity among adult women. *Hellen J Psychol* 2009;6:169-182.
22. Markland D, Tobin VJ. Need support and behavioural regulations for exercise among exercise referral scheme clients: The mediating role of psychological need satisfaction. *Psychol Sport Exerc* 2010;11:91-99.
23. Martins C, Morgan L, Truby H. A review of the effects of exercise on appetite regulation: An obesity perspective. *Int J Obes (Lond)* 2008;32(9):1337-47.
24. Mata J, Silva MN, Vieira PN, et al. Motivational "spill-over" during weight control: Increased self-determination and exercise intrinsic motivation predict eating self-regulation. *Health Psychol* 2009;28(6):709-16.

25. Pelletier LG, Fortier MS, Vallerand RJ, Briere NM. Associations among perceived autonomy support, forms of self-regulation, and persistence: A prospective study. *Mot Emot* 2001;25(4):279-306.
26. Powell L, Calvin III J, Calvin jr. J. Effective obesity treatments. *Am Psychol* 2007;62(3):234-246.
27. Ringle, Wende, Will. Smartpls. In. 2.0 (beta) ed. Hamburg, Germany: University of Hamburg; 2006.
28. Ryan R, Connell. Perceived locus of causality and internalization: Examining reasons for acting in two domains. *J Person Soc Psychol* 1989;57:749-761.
29. Silva MN, Markland D, Minderico CS, et al. A randomized controlled trial to evaluate self-determination theory for exercise adherence and weight control: Rationale and intervention description. *BMC Public Health* 2008;8:234.
30. Silva MN, Markland D, Vieira PN, et al. Helping overweight women become more active: Need support and motivational regulations for different forms of physical activity. *Psychol Sport Exerc*; in press. Doi:10.1016/j.psychsport.2010.06.011.
31. Silva MN, Vieira PN, Coutinho SR, et al. Using self-determination theory to promote physical activity and weight control: A randomized controlled trial in women. *J Behav Med* 2010;33(2):110-22.
32. Teixeira PJ, Going SB, Houtkooper LB, et al. Exercise motivation, eating, and body image variables as predictors of weight control. *Med Sci Sports Exerc* 2006;38(1):179-88.
33. Teixeira PJ, Going SB, Sardinha LB, Lohman TG. A review of psychosocial pre-treatment predictors of weight control. *Obes Rev* 2005;6(1):43-65.
34. Teixeira PJ, Silva MN, Coutinho SR, et al. Mediators of weight loss and weight loss maintenance in middle-aged women. *Obes* 2009;18(4):725-35.

35. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: Review and update. *Med Sci Sports Exerc* 2002;34(12):1996-2001.
36. USDHHS. Physical activity guidelines advisory committee report. Washington, DC: U.S.: Department of Health and Human Services; 2008.
37. Williams GC, Grow VM, Freedman ZR, Ryan R, Deci E. Motivational predictors of weight loss and weight-loss maintenance. *J Person Soc Psychol* 1996;70(1):115-26.
38. Wilson P, Mack D, Grattan K. Understanding motivation for exercise: A self-determination theory perspective. *Can Psychol* 2008;49(3):250-256.
39. Wing R, Hill J. Successful weight loss maintenance. *An Rev Nut* 2001;21:323-341.

CHAPTER 7

General Discussion

“Both theorists and interventionists need to treat a theory as a dynamic entity whose form and value rests upon it being rigorously applied, tested and refined in both the laboratory and the field. To this end, greater advantage needs to be taken of the opportunities that interventions afford for theory-testing and, moreover, the data generated by these activities need to stimulate and inform efforts to revise, refine, or reject theoretical principles (...), a fundamental implication of this perspective is that improvements in both health behavior theory and intervention methods depend on each other.”

Rothman, 2004, p.1

Overview

As it can be read in chapter 6 considering the importance of exercise in successful long-term obesity treatment, understanding the mechanisms behind the development of autonomous regulations, widely viewed as predictors of continued behavioral adherence [e.g. 1, 2-9], is an important topic for conceptual and practical reasons, namely to develop more effective exercise promotion interventions and practices. For its role in energizing the direction and persistence of human behavior, motivation is clearly among the best candidates for predicting exercise participation, including among the overweight and obese [10]. Disappointing long-term results of weight control interventions may be due to the fact that existing weight loss programs largely ignore the potentially crucial element of motivation for sustained behavioral change. Furthermore, in order for interventions to be effective in changing behavior, it has been suggested that a sound understanding of physical activity determinants, preferably via a theoretical framework, is needed [11]. Research on the motivational model proposed by SDT provides theoretically sound insights into reasons why people adopt and maintain exercise and other health behaviors, and allows for a meaningful analysis of the motivational processes involved in behavioral self-regulation. One theme evident in research applications of SDT concerns investigation of the processes by which interpersonal contexts and regulatory motives influence sustained behavioral change and health outcomes. This has led to the development of mediational models aimed at outlining the mechanisms that underlie the effects of motivational variables on psychological and behavioral outcomes. Research as shown that SDT should be useful in explaining the dynamics of motivation during the course of obesity treatment, providing direct empirical support for autonomy, competence, and perceived autonomy support as three of the psychological processes through which intensive behavioral treatment might operate [6, 12, 13].

In the context of exercise, several authors highlighted that autonomous motivational styles mediate effects of interpersonal context on physical activity participation [1-4, 8]. However, one of the recurrent themes of the reviews regarding SDT [14, 15] has to do with the lack of intervention or experimental studies both in exercise domain and weight loss. While cross-sectional, prospective and longitudinal panel designs have provided valuable evidence to support hypotheses from SDT in exercise contexts, these are limited, particularly with regard to the generalizability and the causal inferences that can be made on the basis of such data. Effectively, this kind of studies is needed [14] to provide evidence regarding causal links between variables.

This Thesis aimed to describe and assess the behavioral impact (in short and long-term) of the P.E.S.O. intervention on physical activity and exercise, weight and body composition, and on theoretically-based motivational constructs. Furthermore, it also sought to identify and describe the theoretically-based mediator variables associated with sustained physical activity and weight control. In general, the studies included within this Thesis (set within the context of a longitudinal randomized clinical controlled trial) supported the tenets of SDT (the social contextual characteristics of health care climate, satisfaction of basic needs and different forms of motivational regulation) and its utility in promoting lasting exercise adherence and weight loss, also showing that the aspects of the social environment employed by SDT are amenable to manipulation during a weight loss treatment program.

A detailed reflection and practical implications of each study main results were integrated in their respective chapters. Thus, the aim of this general discussion was just to gather contributions from the different research chapters within this Thesis by summarizing the evidence in the areas addressed and reflecting on recommendations for future interventions and research. Based on main findings, it was considered how SDT's theoretical tenets may be

best acknowledged and manipulated in applied weight control interventions. Limitations of the studies were also pointed as well as potential avenues for future research.

Summary of main research findings

In Article 1 (see chapter 3), evidence regarding the rationale behind SDT's utility in facilitating and explaining health behavior change, particularly sustained changes in physical activity and body weight, was reviewed and a complete description (general format, goals for the participants, intervention curriculum, and main SDT strategies) of the randomized controlled trial under scrutiny was provided. Facing the fact that descriptions of the finer details of program delivery, and especially of the psychological mechanisms underlying successful behavior change are scarce in literature, and that few data are available concerning exercise motivation in the context of weight control, studies in this domain are critical. Thus, this chapter set the ground (by presenting the theoretical foundations and the study protocol) for understanding the next chapters' main results.

Article 2 (see chapter 4) results suggested that interventions grounded in SDT can be successfully implemented in the context of weight management, enhancing the internalization of more autonomous forms of behavioral regulation and facilitating exercise adherence, while producing clinically significant weight reduction, when compared to a control condition. This study' findings are fully consistent with previous studies conducted within this theoretical framework in other areas of health behavior change, adding credence to arguments that social-contextual characteristics of health interventions are amenable to manipulation and play an important role in facilitating the internalization process [14-17]. Indeed, at intervention's end, participants in the experimental condition, compared to controls, reported more autonomous self-regulation (for treatment and for exercise), higher exercise intrinsic motivation and

perceived competence, a more internal locus of causality, and more autonomous motives for exercise. The large effect size, observed in the intervention group for perceived autonomy-promotion treatment climate, added evidence to previous research. It demonstrated that when treatment providers are characterized by minimizing pressure and control, understanding participant's perspectives and regular provision of choices rather than fixed prescriptions [6, 13, 18, 19], they are perceived by participants as being more autonomy-supportive, ensuing self-determined motivational regulations. The significant time X group effects found for intrinsic and identified self-regulation, confirmed that the intervention program increased the process of internalization of autonomous self-regulation for exercise during the first year. Furthermore, other differences between control and intervention groups supported that the intervention also tapped into more general aspects of self-determination (e.g., awareness of self).

Regarding moderate plus vigorous physical activity, the one-year reported average of about 300 min per week was consistent with current physical activity recommendations to achieve meaningful health benefits and also to help sustain weight loss [20, 21]. Also sensitive to intervention influences was the variable we named lifestyle physical activity, including parking further away from one's destination, taking the stairs more often, standing instead of sitting, etc., for which a large effect size favoring intervention was observed. Significant between-group differences for weight loss and for changes in body composition were also found. With this regard it is important to notice that, comparing to controls, participants in the intervention group not only achieved significantly more weight loss, but the relative amount of weight loss from baseline ($7.3 \pm 5.9\%$) was consistent with recommendations regarding the magnitude of weight loss necessary to reduce health risk [21, 22].

Consistent with the *main effects* of the intervention trial on putative mediators and outcomes previously reported, the central tenet of **Article 3 (see chapter 5)** was to test a theoretically-

based process model by which the intervention produced its effects on different types of physical activity (structured and lifestyle forms of physical activity), searching for specific mechanisms by which the intervention produced its effects. Aligned with the theoretical tenets of SDT, and convergent with previous research, but extending it into the context of a randomized controlled trial, this study results indicated that the intervention participant's perceptions of a need supportive environment had positive effects on the satisfaction of the needs for autonomy and competence, leading to more autonomous forms of exercise motivational regulations. Autonomy need satisfaction emerged as a negative predictor of external regulation, but positively predicted the more self-determined motivations (identified and intrinsic). Competence also positively predicted autonomous motivations and had no effect on external regulation. Thus, feelings of choice and volition about what types of activity are engaged in, as well as perceptions of competence that they can effectively perform the chosen activities, were highlighted as important to the development of self-determined motivation towards exercise.

Results also showed that moderate and vigorous exercise was positively influenced by intrinsic motivation (identified regulation was not a significant predictor of physical activity in the presence of the other regulations; see chapter 5 for more details). Specific mediation tests supported SDT assertions, stressing that the experimental supportive context explained the adoption of moderate and vigorous physical activity due to its effect on the satisfaction of autonomy and competence needs on intrinsic motivation. Differently, lifestyle physical activity was not significantly predicted by motivational regulations. Thus, it seems that the processes by which the intervention promoted these two types of physical activity were different and more direct in the second case (lifestyle activity) – a behavior which is not as intrinsically motivating and that requires little competence. The absence of mediating effects from self-regulations found in this study is consistent with past research [1]. Several

explanations can concur to this finding. First, lifestyle physical activity at least as it was assessed in the present study, was concerned with more habitual and automatically enacted behaviors (and thus not needing deliberate, conscious self-regulation). Second, if according to the internalization-automatization hypothesis, self-determined motivation can be internalized to the point that regulation becomes automatic [23], and lifestyle physical activity could represent a more habitual, automatic behavior, then the present study's results may not preclude the hypothesis that identified regulation plays an important role in this behavior. The intervention may have worked in the promotion of lifestyle physical activity through the internalization-automatization of identified regulation. It could be that this mechanism was not captured because of the explicit nature of our measures, stressing the need for implicit measures [24].

Generally, results provided support for using the SDT framework to understand physical activity motivational processes in the context of weight management, indicating that targeting a motivational climate designed to support autonomy, structure, and involvement will encourage individuals to develop more autonomous regulations, setting the ground to the discovery of personal meaning and enjoyment of exercise at least in its moderate and vigorous forms.

As a next step in validating the effectiveness of SDT based interventions for exercise promotion in the field of weight control, **Article 4 (see chapter 6)** aimed at exploring the already stated associations in the long-term (i.e., follow-up period of two years), searching for a more in-depth understanding of the dynamics of motivation, by analyzing the extent to which experimentally-manipulated perceived autonomy support, motivational regulations and sustained exercise participation mediated the impact of the behavioral weight control intervention on 3-year weight change. Indeed, effective testing of theoretical models within an

intervention trial requires longitudinal assessment of theoretical constructs, followed by mediation analyses [25].

This study results, utilizing controlled longitudinal methodologies, showed that treatment had significant effects on 1- and 2-year autonomous self-regulation, 2-year physical activity, and 3-year weight change, and clearly indicated that long-term exercise participation had a significant effect on weight loss success at 3 years, and partially mediated the effect of treatment on weight change. It was also demonstrated that not all types of motivation predict long-term behavioral outcomes and that autonomous regulations are the critical intermediate mechanisms. Furthermore the effects of autonomous self-regulation on 3-year weight change were only partially mediated by physical activity. Thus the remaining effects of exercise motivation presumably affected weight through alternative pathways. “Spill-over” effects are one possibility demonstrated by a recent study where increased general self-determination and exercise motivation facilitated improvements in eating self-regulation during weight control in women [26].

In summary, this longitudinal, controlled, application of SDT to promote physical activity adherence and weight management provided strong evidence for a link between experimentally-increased autonomous motivation and exercise and long term weight loss maintenance. Results highlighted the importance of interventions targeting the internalization of exercise behavioral regulation and making exercise and physical activity positive and meaningful experiences, rather than simply focusing on immediate behavior change, in overweight/obese women.

Understanding success and failure in promoting long-term behavioral change in the field of obesity management

By enhancing our understanding of the mechanisms by which an intervention works in promoting the targeted outcomes, and allowing experimental testing of key relationships in a controlled fashion, this and other randomized controlled trials can provide ways to develop and implement intervention programs that enhance autonomous motivation and significantly contribute to the development of more cost-effective interventions. The findings of the studies conducted in the context of this Thesis have positive implications for behavioral interventions and health promotion programs aiming at promoting long-term physical activity adherence and weight control. Results from our work prompted a profound reflection about the actual weight loss scenery and the disparities regarding theory and common everyday practice. Reflecting on both the conceptual framework offered by SDT and our own studies' results, and sketching the future, the question is whether we can translate it to other weight loss behaviors (or to the process of weight loss itself) what we learned from SDT applied to exercise behaviors.

Current weight loss attempts: Problems with actual motivational targets

As it can be read in chapter 3 concerning weight loss, self-determination theory [27] suggests that the lasting behavior change necessary for maintenance depends not on complying with demands for change but rather on accepting the regulation for change as one's own. Supporting this position two recent reviews regarding successful weight management [28, 29] highlighted the role of internal motivation to lose weight, autonomy, assuming responsibility in life, and overall more psychological strength and stability. Furthermore, factors that may pose a risk for weight regain include external pressures. The recognition of these behavioral

mediators of health outcomes suggests that we attend more carefully to the patient's experience and motivation.

Having said that, when we look at the actual behavioral change interventions and health care contexts in the field of obesity, it may be that many people may feel pressured by a "should/must/have to" paradigm, many times aggravated by the prejudice in this field. The current environment seems to encourage external regulations regarding body weight and physical appearance in general [30]. On the one hand, implicit social messages may lead people, women in particular, to believe that thinness (and youth, beauty, fitness) will automatically bring about happiness and well-being. On the other hand, obese people are discriminated in critical areas of life such as employment opportunities and health care [31], and it is perhaps not surprising that too many people desire (and actually attempt) to lose weight in such large numbers. SDT researchers have proposed that goals which are more "extrinsic" are typically associated with less internal forms of motivation [16]. For example, in the field of exercise adherence two recent studies by Ingledeu and Markland [32, 33] used mediation analysis to show that nominally intrinsic goals predicted exercise participation indirectly through autonomous forms of self-regulation; health/fitness and stress management goals predicted identified regulation whereas affiliation and challenge goals predicted intrinsic motivation. Contrarily, as expected from theory, controlled participatory motives (social recognition, appearance/weight) predicted external and/or introjected regulations. According to SDT, the link between endorsing more intrinsic goals and the development of autonomous motivation is through the fact that these (intrinsic) goals are more closely aligned to people's basic psychological needs [16].

However, a large number of individuals who attempt to lose weight suffer from introjected pressuring forces and social constraints that value thinness above fatness [34]. There are many factors that may lead people to emphasize weight loss goals that are not need fulfilling. For

example, exposure to the commercial media can prompt a locus on external appearance. Aiming at social acceptance and status through physical appearance or at goals associated with protecting self-worth and self-esteem (e.g. avoiding social discrimination) is unlikely to promote intrinsic and autonomous forms of motivation. In fact, a tendency to evaluate self-worth in terms of weight and shape has been associated with weight regain [35]. Ogden et al. [36] compared successful weight “maintainers” with “regainers” and noticed that the former endorsed significantly more reasons such as “increased self-esteem, to like myself better, and feel better about myself” than those who regained weight (no difference for reasons related to health, appearance, or external pressure). Other authors have highlighted the role of “*taking control and full responsibility for lifestyle change*” and displaying a “*healthy narcissism*” [28], “*being conscious of one’s behaviors*”, and “*confronting problems directly*” [37], as predictors of successful weight maintenance.

Thus, it seems that although scientific evidence is pointing in one direction (the importance of self-investment and well internalized goals to lose weight), social reality is leading the field in the opposite direction...

Weight loss: outcome or process?

The previously reported excessive reliance on external sources of motivation to lose weight can be related to another aspect which may also contribute to hinder weight control attempts, especially in the long-term: an approach to behavior change which primarily favors its *results* or *outcomes*, specifically losing a given amount of weight, objectively quantified.

A primary focus on weight – a number on a scale – as the measure of success and regarding exercise and diet as mere means to an end (weight loss) presents at least two problems. It may tend to minimize the importance of the *process* (i.e., the personal experience) of losing

weight, being physically fit, etc., and its inherent attributes and immediate consequences. Whether exercising is difficult, pleasurable, or simply boring becomes less critical; it is something that simply has to be done in order to burn calories and meet the energy deficit goal. Although changes in eating patterns can have profound effects on people's lives, quite often the goal of reducing fat at lunch or of having breakfast at home is valued primarily for its utilitarian role. Whenever this happens, opportunities may be lost to tap into potential sources of meaning and personal enrichment which are at the heart of the weight management process (e.g., learning new cooking skills, having more time for family meals, enjoying different foods, etc.). For instance, many sports and physical activities can clearly be a great source of fun and of optimal challenge to the point of being adopted for primarily intrinsic motives [38]. These changes alone can be beneficial and may carry their own "motivational energy" with which a person can identify and subsequently integrate into their lifestyle repertoire, regardless of additional consequences.

The results of study IV underlie these assumptions by highlighting the importance of an increased focus on making exercise a positive and meaningful experience rather than simply attempting to change behavior. External (or introjected) contingencies can produce results but they are a short-term solution for a long-term problem. In the general population, research has now consistently shown that maintenance of exercise is especially related to the *process* and the quality of the exercise participation experience, which emphasizes intrinsic or well-integrated motives [14].

Research from attempting cessation from smoking, alcohol, etc. have shown that most people do not change behavior based on long-term consequences. Indeed, outcome-focused, short-term approaches to change, makes motivation more critical early on. However, motivation is an issue not only upon entrance, but throughout the behavior-change process. However, in the long run, for example, overemphasizing the positive outcomes of exercise can actually

undermine an individual's motivation for exercise. Specifically individuals can become so focused on obtaining these outcomes (extrinsic motivations) that they ignore the process of developing positive inner experiences with movement and exercise (intrinsic motivation). Beyond initial motivation, self-motivation or autonomy for change can become more critical over time as continued behavioral changes require overcoming obstacles, persisting through rough spots, or sustaining action when the initial impetus and reinforcements are no longer available. For example, a prospective study with competitive swimmers, testing a model incorporating perceptions of coaches' interpersonal behaviors (autonomy support vs. control), self-regulations, and persistence, found that although introjected regulation was a significant predictor of persistence at Time 2 (10-month) it became nonsignificant at Time 3 (22-month) [4].

A second limitation around an utilitarian view of lifestyle change is that whenever results do not meet initial expectations, take too long ("not worth the effort") or even *because* results are achieved, people may find themselves missing a good reason to continue their exercise and/or dieting efforts. It is also noteworthy that a focus on fast results may exacerbate these problems. For instance, more aggressive lifestyle changes are correspondingly less likely to be explored for its inherent interest and instead valued only for their results. They typically do not last, and that is the fate of the weight loss they induced.

Controlled and self-determined regulations and the question of rigid vs. flexible approaches to change

It could also be that the mentioned excessive focus on results (and less engagement with the *process*) represents a more rigid and dichotomous approach to weight control, underlying reduced psychological flexibility (e.g. an all or nothing approach) [39]. Indeed, in behavior

change and weight loss, the goal is often fixed and rigid (e.g., to lose certain amount of weight, exercising X minutes per week in order to something...). Conversely intrinsic goal reflects a more flexible approach by being related to the process of change more than specific outcomes; it is about a long-term behavioral choice rather than a quick-fix, minimum effort - maximum gain behavior. A rigid approach may result in short-term effort, but such behavior is likely to be characterized by superficial engagement and threats to one's competence if one does not achieve one's goal. Such experiential factors are unlikely to foster adaptive engagement in the long-term. With this regard, there are indications that this dichotomous (achieved/not achieved), psychological pattern towards controlling one's weight, as well as a rigid control of eating negatively predict success [28, 29].

In fact, on achieving their goal, those pursuing extrinsic goals reported short-term satisfaction of their goal achievement but this was quickly followed by feelings of "what next?" and self-imposed pressure to maintain their gains. Further, increasing pressure toward specific outcomes impacts both selectivity and therapeutic focus, which yield motivational implications [38]. In contrast, intrinsically oriented participants aspired to continue their exercise engagement by autonomously setting new, more challenging goals [39]. Thus, it appears that if we are really to help overweight individuals develop for example positive exercise habits that will last a long time, we need to focus more on making the exercise a positive experience rather than simply attempting to change behavior. External cues result in a short-term solution for a long-term problem.

Autonomous and controlled self-regulations: the issue of creating versus depleting energy for action

Why external and internal imposed pressure and control are only a short term solution? What is the reason for something working in the short term to fail in producing effects in the long term?

Baumeister, Heatherton, and Tice [40] proposed that the failure to exert the necessary control over oneself could occur because people do not have the strength to maintain self-regulation (i.e., under regulation), or because they try to exert control in a way that fails to bring about the desired result (i.e., misregulation). SDT suggests that distinctions between forms of regulation along a continuum of self-determination may account for the lack of strength to maintain self-regulation and for the reasons why people fail to exert or maintain control over themselves, suggesting that some reasons for misregulation may be associated with forms of regulation not well integrated into the self.

Exercising self-control (in the sense of pressure) seems to produce a psychic cost. The exercise of self-control, in general, constitutes a limited resource that can become temporarily depleted after use. As a result, the depleted self is less able to carry out further acts of self-regulation. This phenomenon of self-control depletion, also known as “ego-depletion” [e.g. 41], has been demonstrated in a wide variety of situations [41]. For example, people who refrained from eating tempting chocolates were less persistent at a subsequent problem solving task compared to people who had not exercised impulse control [41]. It is important to notice, however, that the effects of depletion are said to apply only to behaviors and self-regulation that require controlled and effortful processing. SDT emphasizes, however, that different regulatory approaches have diverse relations to psychological energy and vitality, and therefore the depletion is not inevitable [42]. In other words, the experience of self-

determination is less depleting than non self-determination. That is, to the extent to which a behavior or course of action is personally endorsed and engaged in with a sense of choice and volition, as opposed to being associated with a need to comply or with feelings of pressure and tension, often manifested in expressions like “I should”, “I ought to”, “I must”, less depleting it will be.

The more a motive is self-endorsed and effectively rehearsed and integrated, the more is theorized to operate harmoniously and preconsciously, without the expenditure of effort. Thus, such spontaneous regulation may remain intact when distracted, tired, or when not actively using self-control. Such possible congruence and automaticity in self-regulation, in turn, is liable to help explain why self-determined regulation is so much more effective and consistent, especially given the toll and disruption of our everyday cognitive lift. Indeed, research suggested that we are often too tired or mentally taxed to exert conscious, effortful self-control [41]. Perhaps internalizing the importance of a goal, as it is done when one has an identified self-regulation, leads individuals to construct mental scripts for how to pursue their goals that, subsequently, they are able to follow in a less depleting fashion. For example, instead of external control (rewards/punishments) regarding stop eating high-energy density foods, a person could develop a sense of himself as a healthy eater “What I eat is a part of what I am” and everyday food choices become a part of something bigger, reflecting one’s values and choices (and not rigid rules, adherence to a dietary prescription and other controlling sources).

Interestingly, according to SDT, autonomous regulations can function as energy creators. For instance, a person’s running routine may be motivated or “energized” by both the physical enjoyment he/she feels while running *and* by the value attributed to its longer-term consequences such as fitness and cardiovascular health. Thus, it is theorized that entrenched, rehearsed, and personally-important self-determined motives, besides not requiring the time

and deliberation involved in controlled regulations, are theorized to operate through the highly satisfaction of basic needs, thanks to their self-originating nature. Thus, motivational regulations will vary in the extent that they are assimilated into or remain *located* outside the true self. This is a view which emphasizes how the behavior is *energized* and is concerned with the extent to which regulatory motives are aligned (or work against) the fulfillment of inherent human needs.

Indeed, to understand the different effects in terms of energy depletion (and the long-term consequences) of autonomous and controlled regulations, it is necessary to understand the *self* as viewed by SDT. According to Deci and Ryan [17], humans are born with a tendency to seek interesting activities and to naturally integrate cultural norms, extrinsic demands, and emotional experiences into the set of flexible, unified regulatory processes, values, and structures needed to volitionally engage in the world with vitality, self-coherence, and positive psychological health [16]. Throughout life, this integrative and self-actualizing process will succeed to the extent the innate psychological needs of competence, autonomy, and relatedness are nurtured by the social environment. If they are not, compensatory needs, goals, and motives will develop, which can also energize and direct behavior, sometimes very powerfully, but often at the cost of health and well-being.

Research of the hypotheses forwarded in Basic Needs Theory is still in its infancy relative to the empirical research concerning the correlates of motivational regulations in behavioral persistence. However, from the organismic-dialectic SDT perspective, the relationship between intrinsic regulation and psychological need satisfaction can be termed as reciprocal/bi-directional, highlighting the multi-faceted function of psychological needs. Specifically, if basic needs function as a necessary requirement of the human integrative tendency (critical antecedents to optimal functioning), they could be also impacted by this internalization process (e.g. intrinsic goal pursuit being conducive to psychological need satisfaction).

Supporting the SDT-based hypotheses of a human integrative process within the exercise domain, a number of studies have documented positive associations between more self-determined forms of exercise motivation and exercise-based psychological need satisfaction [e.g. 2]. Longitudinal work employing multiple measures of goal content and psychological need satisfaction would also provide information with regards to this reciprocal energizing effect. Emotional health, self-congruence and self-worth, and psychological markers of well-being may also feed back into continued motivation in important ways.

The role of well-being (fostered by Autonomous regulations) as helping long-term behavior change

Autonomous regulations, i.e., choosing one's course of action relatively free from pressuring forces are commonly associated with improved psychological well-being and vitality. Some studies [43-45] report findings indicating that autonomous motives and the satisfaction of psychological needs are associated with indicators of well-being, in accordance with SDT. In particular intrinsic and identified regulations are positively associated with positive affect, enjoyment and satisfaction [45].

According to SDT, integrative processing is the mechanism through which growth, learning, and change within the individual occurs. A heightened level integrative processing produces positive affect, and reciprocally, this positive affect may then act as a further incentive for the individual to approach challenging tasks in the future and as a reinforcer for such engagement once it has occurred. Indeed, supporting these reciprocal effects, Isen and colleagues showed that positive affect leads to a kind of thinking that is flexible [46] and creative [47]. In this way, positive emotions stimulate growth, integration and motivation.

Thus, a more in depth look at the mentioned relationship may raise the hypothesis of well-being as reciprocally leading to the formulation of more intrinsic goals and self-determined actions. The way we view ourselves and our bodies affects our well-being and our behavior. Self-esteem and physical self-worth have been shown to have emotional adjustment properties and several lines of research indicate that self-esteem and self-perceptions of competence determine our choice and persistence in behaviors. We tend to avoid settings in which our inadequacies are exposed, and to develop our identities around aspects of life in which we feel comfortable and rewarded.

According to Rodhes [48], emotion and affective qualities receive limited attention from social psychologists in the attitude tradition and expectancy models. From a mechanistic point of view, if exercise research has demonstrated repeatedly that it is causally linked to core affective states [49] from pleasure to discomfort and affective conditions of well-being such as depression and anxiety [50], it seems logical that judgments or expectancies about these states would be extremely important to future behavioral performance [48]. From a larger theoretical perspective, temporally proximal outcomes are often more important to human action than distal outcomes [51]; and affective outcomes are usually more immediate than instrumental outcomes in physical activity (Rodhes, 2009). In that sense, Rodhes (2010) defended cognitive processes as influencing or mediating the effects of core affect on behavior. Affective associations can signal decision choices without the individual having to work through the cognitive beliefs each time a decision is made and allowing people to make decisions more quickly and efficiently. According to the mentioned author, SDT highlights the importance of affective judgments to behavior in their intrinsic regulation construct and autonomous motivation more generally.

These facts have important theoretical and practical implications, often ignored, to the field of long-lasting behavior change, especially obesity studies, but there are suggestions that, for

example, improved self-worth and body image are associated and can benefit weight control [28, 29]. Knowledge concerning the nutrients essential for positive motivation and experience and, in turn, for enhanced performance and well-being has broad significance for the field of obesity management. Supporting these tenets, Elphag and Rossner [28] suggested that healthier traits reflecting a more completely developed and integrated personality, including areas such as relating and ego-strengths with impulse control and overall better functioning can imply better chances to maintain weight loss. A consistent pattern emerges where the person likely to succeed in maintaining a lower body weight has a personality functioning with more strengths and stability. Such strengths include a capacity for control and also the ability to handle relapses in a balanced way and to recover again. The thinking style inherent in flexible control implies greater maturity.

Unfortunately, the role of psychological and emotional well-being in weight control is under-investigated, namely the extent to which it causally contributes to positive behavioral outcomes. Recent studies indicate that improved body image in particular could be beneficial to eating self-regulation and long-term weight control [e.g. 52, Carraça, Personal Communication]. This could be in part due to its relations with self-determination [53].

Weight loss interventions: A continuous care reality?

A recent review of obesity interventions argued that “The idea that a lifestyle intervention for obesity should occur for a discrete period of time, terminate, and then have lasting effects over the duration of one’s lifetime is outmoded. All of the successful lifestyle trials kept the treatments going for the duration of the follow-up. Most initiated change with a more intensive phase and followed it with a maintenance phase in which treatment contacts were reduced to monthly or bimonthly” [54, p.243]. The concept of continuous care in weight loss

and maintenance comes about because once the care is removed weight is regained over time, such that as the intervention is extended weight regain is delayed, although not prevented. Perri and colleagues are major contributors to the idea of continuous care [55, 56]. The authors have shown repeatedly that by extending the intervention by frequent follow-ups with professional contacts, support groups, therapy groups, relapse prevention training, the rate of weight regain is slowed or postponed by as much as one year [56].

These last considerations posed at least two main questions weakening the defense for a continuous care model: i) it is very unlikely that large numbers of overweight and obese adults can ever be treated and supported for life by trained health care professionals in a cost-effective manner; ii) as it is mentioned the continuous care solution only seems to slow or postpone (by as much as one year) the rate of weight regain...

We believe, based on all the arguments and reflections exposed in this discussion section, that there are clear and sound theoretical and empirical indicators constraining this continuous care model (underlying the development of controlled regulations). Conversely, for all the reasons already pointed, autonomous self-regulation can be one of the missing links to successful weight control.

Facing Powell's statement that "Patients tell us, in a number of ways, that they need ongoing treatment" [54, p.243], it is important to reflect on what patients might really mean by their preference for a continuous treatment model and its implications (would they like verbal encouragement and support? up-to-date technical information? pressure from a third party and shared responsibility for their progress?). This statement, if accurate, can be interpreted in at least two ways. One is that people simply lack self-confidence and do not trust that they possess or will ever acquire the skills necessary to successfully manage their weight. As we have alluded to previously in this text, this appears to be the default view underlying current

obesity treatments, along with the belief that even if it is initially high, motivation will inevitably dwindle soon thereafter. Thus, by teaching behavioral skills and increasing self-efficacy (which would then build continued motivation), people should find their successful pace to weight control. Another interpretation is that, from the beginning of treatment (or through other social messages learned even before treatment is initiated), patients have internalized the message that their condition is to be dealt with by procedures and techniques (e.g. medications) essentially under the control and responsibility of an external expert. If individuals do generally expect to be told what to do in order to manage their condition (e.g. receive a dietary/exercise prescription, take a medication), this in itself could constrain motivation from the start, reinforcing a clear external locus of causality, particularly if therapeutic options are not discussed and a clear rationale for each decision is not discussed. For instance, to the extent patients or study participants are “motivated” by what could take place at the next meeting or phone call with a health professional / study interventionist (e.g. praise or criticism), or have internalized (introjected) controlling cues (e.g. everybody says that I should join a gym) without taking true responsibility for the process and its outcomes, this would per se diminish their internal motivation for their action’s. In opposition, from an SDT perspective [27], lasting behavior change depends not on complying with demands for change but rather on accepting the regulation for change as one’s own. In other words, it requires internalizing the regulation of relevant behaviors and integrating them with one’s sense of self and one’s aspirations, values and goals, so they can become the basis of autonomous regulation.

The professional’s role is to help people make the transition from “should” to “want to” motivation. It’s not enough to teach people what to do. Based on the research available, it’s also important to pay attention to the fit of the target behaviors in the person’s whole life. Help them with scheduling challenges by offering activity alternatives that the person is

capable of and has access to. Also, and perhaps most crucially, it's important to create an environment where people feel comfortable and supported. Pay attention to the social aspect. People don't want to feel or look out of place compared to others in the context. Unfortunately, it's far easier to undermine motivation for long-term behavioral adoption, than it is to bolster it.

For example, from an SDT perspective, exercise interest and enjoyment depends on experiencing the intrinsic satisfactions of skill improvement, personal accomplishment, and excitement—rather than being the result of extrinsic factors such as losing weight, avoiding illness, or pleasing others. The challenge is thus on the side of health professionals to effectively target and change the most important mediating mechanisms, while discarding the least effective, for the (long-term) benefit of those who seek their expert guidance.

Practical implications and future directions: Autonomously motivated weight loss, is it possible?

The importance of fun, enjoyment, challenge

With the goal to promote greater behavioral adherence, there is a need to create more enjoyable environments. Most of the people never really changed their lifestyle or found a way to eat and exercise that was fun and enjoyable and that they could keep up for a lifetime. Fortunately, a wide variety of sports and physical activities are available, and these provide many opportunities for self-chosen optimal challenges that can help *all people* enjoying the sense of autonomy and mastery that underpins intrinsic motivation. By their very nature, most physical activities are intrinsically appealing because of their benefits to personal wellness, and because of the fun, excitement, and thrills that can result from participation in them. Developing intrinsic motivation and enhance their self-esteem may include strategies such as

encouraging people to try various exercises to find what they like and feel competent at, to “multitask” while exercising (e.g. read a book, listen to music, or watch a favorite TV program), emphasize the exercise benefits related to improved quality of life and health (vs. the perfect physique), encourage to focus on one’s own improvement, not others or some societal ideal, emphasize the more intrinsic, positive psychological benefits of exercise. Feeling of fun depends on experiencing the intrinsic satisfactions of skill improvement, personal accomplishment, and excitement—rather than being a result of extrinsic factors such as winning, getting rewards, or pleasing others. Furthermore a central tenet focus on the process instead of the product of these movement activities, research and experience have consistently showed that maintenance of exercise is related more to the process of movement, which emphasizes intrinsic motives.

Moreover, this is also applicable, with the necessary adaptations, to the field of eating behavior. Cooking/baking for fun was more common among successful weight losers [57]. Perhaps those who enjoy cooking, have meals at home more often (healthier than in restaurants higher in total calories, fat, and sodium and lower in fiber). This may also represent the importance of a positive relation with food.

Finding other directions: personal values and self-actualization as a valid goal in treatment?

For many people, for many reasons the health behaviors necessary to weight management are not intrinsically enjoyable or interesting, the primary reason people to initially perform such actions is because the behaviors are prompted, modeled, or valued by significant others, with the already discussed consequences. Motivationally, we want people to get to a point where they want to exercise because they think it is important. This is identified motivation. We

want to help people focus on their own valued goals (e.g. health, fitness, improved well-being) as well as behavioral goals (i.e., actually doing the exercises or attending a certain number of sessions per week).

With this regard motivational interviewing techniques applied to health care settings [58] may represent a tremendous help. A core principle of motivational interviewing is that individuals are more likely to accept and act upon opinions that they voice themselves. This implies encouraging individuals to work through their ambivalence about behavior change and to explore discrepancy between their current behavior and broader life goals and values [59]. A related strategy is to help clients experience discrepancy between their current behavior and their personal core values or life goals; this can lead to values clarification. In order to stimulate this, the health professional can ask/obtain goals and values from people using open ended questions, then it can be asked how if at all that person might connect the health behavior in question with his or her ability to achieve these goals or realize these values. Alternatively, the health professional may ask how changing the health behavior would be related to these goals or values. This example it is helpful in order to help building discrepancy between the client's current actions and his or her broader life goals and values (Resnicow, 2007, personal communication).

Thus, it is important that practitioners center their work on having participants exploring more stable values and goals. Health improvement is one example. Indeed, according to the Eurobarometer [60] in what concerns to individual reasons for exercising, health is the main consideration for European citizens when it comes to exercise (61%), followed by improve fitness (41%), relax (39%), having fun (31%) and improve personal appearance (24%) and weight control (24%). Be with friends; develop new skills, for the challenge, were also other motives mentioned (although in small numbers). Also in Portugal, the major reason presented

for exercise is health (65%), other motives like relax (35%), fun (30%) and control your weight (20%) are manifested in much smaller numbers.

However, it is important to notice that using the improvement of health as the explicit goal of treatment may again focus the process on the attainment of a mostly “external” goal, perceived as distal and possibly removed from the person’s current experience. SDT is concerned with human thriving and growth, and with the quality and vitality of the human experience [16]. Could there be a place in lifestyle change interventions to create the conditions for patients to strive for goals beyond physical (and mental) health improvement, namely using the “canvas” of health behaviors such as eating, sports, and exercise? Could the internalization process in obesity behavioral treatment also be seen as the starting point for active self-actualization, for instance through learning new abilities and routines (e.g., becoming the cook of the house), relating to one’s body in ways previously unknown (e.g., using dance as a form of physical activity), or crafting a renewed personal identity (e.g., in the building of an exercise identity, individuals seem to reach a stage where they become to view exercise as central to their weekly routines and who they were. Thus, the exercise becomes self-reinforcing which leads to adherence despite previous barrier perceptions). Hence, for example exercise professionals can develop integrated regulation by encouraging participants to think of themselves as exercisers or “recreational athletes” and to incorporate this thinking into other aspects of their lives. For example, an exerciser would choose active leisure (e.g., walking and talking rather than sitting and talking) and would give priority to exercise when possible. This will increase the probability that the new exerciser will feel self-satisfaction after exercising because it is congruent with his/her sense of self [14].

Although it is unlikely that personal transformation and individual growth can ever be explicitly stated as therapeutic aims in obesity treatment, it is no less true that quite often the behavior modifications required for reverting a person’s weight gain (e.g. radically changing

the way we eat; choosing different occupations for one's leisure time) have the capacity to highly influence, if not downright impinge on the way people had freely chosen to live their lives to that point. Perhaps acknowledging the potential for self-actualization embedded into lifestyle change programs, most especially those who involve repeated contact with health professionals and that are higher in intensity [e.g.61], and proactively addressing these aspects during treatment, is the most ethical approach. If autonomy and competence are recognized as human psychological nutriment at the most essential level (that of a basic need), and if interventions that promote the fulfillment of those needs are built, then health professionals should perhaps be increasingly prepared for the possibility that at least some individuals will thrive in that environment and reach a level of personal change much beyond that which is currently meant by "behavior change". Whether long-lasting changes in eating and physical activity (and consequently in body weight) can in the future be reliably traced back to deeper personal transformative experiences is unknown. Meanwhile, studies in the area of exercise and physical activity clearly show that perceived need support and autonomous self-regulation are consistent predictors of behavior adoption and maintenance [e.g. 1, 4, 5, 8]; the close association between long-term weight control and regular exercise that indicates the same pattern of association could be observed in weight control.

Limitations and Future Research Directions

The particular limitations of the four studies presented in this Thesis were considered individually in Chapters 4 to 6. Therefore, this section aims to discuss more general limitations to the collective body of work and integrate these with avenues for future research that appear worthy of consideration.

One limitation concerns the targeted population, only pre-menopausal overweight and obese women; consequently, the extent to which the present findings are generalizable remains to be determined. Further investigations involving both sexes and a sufficient number of participants from minority ethnic groups (since the vast majority of participants were white) are required to fully support SDT's applicability across populations. Until then, there is no evidence upon which to discuss gender and culture-specific issues regarding the impact of autonomy on obesity-related health behaviors.

Another limitation, addressed in all the chapters, concerns the lack of baseline assessments for exercise and treatment-related self-regulation outcomes, which preclude us to use change scores (except for weight and body-composition data). Indeed, several baseline SDT measures could not be assessed at baseline, because some questionnaires pertained intervention-related aspects (e.g., perceived autonomy support by the intervention team). Regarding exercise psychosocial measures, the questionnaire used to assess self-regulation (SRQ-E) did not contemplate a scale of amotivation (a completely non-self determined form of regulation reflecting a state where intentions to engage in a exercise behavior are absent). Given the fact that our baseline sample was mostly sedentary, responses to self-regulation and locus of causality for exercise questionnaires (e.g., "I try to exercise on a regular basis because...") were deemed as less valid at baseline and, thus, not used (also for consistency with the analysis for treatment-related variables). Nevertheless, we compared baseline scores between intervention and controls for general self-determination variables (e.g., SDS). These and other analyses we have conducted (unrelated to this study; e.g. for eating behavior and psychological well-being variables) have given us, thus far, no reason to question the adequacy of our randomization process. In this regard, we agree with Michie & Abraham [62] that behavior change only indicates intervention success when naturally occurring change is

controlled, and that baseline behavior rates may be controlled statistically or through adequate randomization (which we believe to be the case).

It is also important to notice that studies only included self-reported measures of physical activity. Despite the fact that the PESO Trial also included accelerometers in the measurement protocol, data from accelerometers is yet under analysis and could not be incorporated in real time. However other preliminary studies from our Lab, using the data already available (limited), showed consistent correlation patterns between accelerometers and data from pedometers and the 7 DAY-PAR.

Besides the benefit from utilizing objective measures of exercise, future studies should also include “bio markers” of success (e.g. reduced blood pressure) and “mental health markers” such as improved self-esteem, vitality and reduced depression symptomatology and anxiety (given that according to SDT only self-regulated behaviors can translate in such mental health outcomes; other research projects from our Lab are currently exploring these issues). Extending SDT’s applicability beyond behavioral engagement is an important step for SDT research to influence health care policy and delivery.

The absence of implicit measures represents another limitation of the present study. As it is stated in chapter 5, self-determination researchers traditionally measure motivation regulation on an explicit level. A next step in validating the effectiveness of SDT based-interventions will have to more accurately examine the possibility of automatic processes in self-regulation, adding further explanatory power to the theoretical framework. Thus, the development and validation of implicit measures of motivation is a fundamental step to build future SDT research.

As a final caveat, it should be noted that this Thesis only addressed mediators. Indeed, considering the higher behavioral persistence hypothesized by SDT to result from increased

autonomy and internal motivation, our main interest resided in the mechanisms of change promoted by an SDT-based intervention. Thus we conducted mediation analyses to identify the most relevant processes of change associated with the primary outcomes (not only at intervention end, but also at follow-up). In chapter 3, when describing the P.E.S.O. trial main research aims, it was stated that individual differences in general causality orientations would be evaluated as moderators of intervention effects. However, within the context of the present Thesis such putative moderators were not tested. A moderator of treatment is a pre-treatment or baseline variable that identifies subgroups of patients within the population that have different effect sizes [25]. In studies in which moderators are ignored, effect sizes may be biased, power attenuated, and clinically important information overlooked. If such analyses were performed, it could also be useful to investigate the savings that might accrue as a result of the identification of moderators of treatments, both in terms of impact on clinical decision making and influence in the more cost-effective design of future studies. Thus, future SDT research needs to consider these issues when attempting to glean a better understanding of how individual factors contribute to the development of self-regulation and to account for more explained variance in the exercise and weight loss domain

In sum, more research is needed, we have to think about how individuals can achieve an autonomous, self-regulated lifestyle to achieve long-lasting weight control in our obesogenic environment and we suggest that taking a closer look at different dimensions of motivation is a first step towards this goal. This Thesis was only concerned with physical activity sustained adherence in the context of weight control. Eating behavior should also be analyzed in the future, in order to explore if the motivational sequence embedded in SDT also applies.

Summary

The present Thesis was set within the longest RCT to date that evaluated autonomy support and physical activity behaviors and long-term weight-management. Taken collectively, results showed that the intervention was successful in promoting exercise autonomous self-regulation, and also physical activity behaviors. Additionally, it also indicated that the motivational sequence proposed by SDT (i.e., need-supportive health care climate, leading to need satisfaction for autonomy and competence, leading to autonomous exercise regulation in turn leading to exercise behavior) was empirically supported. The role of the intervention through perceived autonomy and competence support was particularly effective in increasing exercise intrinsic motivation, which in turn significantly predicted minutes of moderate and vigorous physical activity at 1 and 2 years. Also, results support a mediation effect of need support and need satisfaction (of autonomy and competence needs) for developing identified and intrinsic regulations for exercise, which in turn were found to predict 3-year weight control.

In closing, we have highlighted some of the key findings and we have also discussed theoretical implication of the findings to clinical practice. In particular we have highlighted the important role of autonomous self-regulation (within the theoretical framework offered by SDT) and suggested that it might be one of the missing links to successful weight control. In the general population, research has now consistently shown that maintenance of exercise is especially related to the *process* and the quality of the exercise participation experience, which emphasizes intrinsic or well-integrated motives [10, 14]. We have now shown the same applies to overweight and obese persons. The challenge is thus on the side of health professionals to effectively target and change the most important mediating mechanisms,

while discarding the least effective, for the (long-term) benefit of those who seek their expert guidance.

References

1. Edmunds, J., N. Ntoumanis, and J. Duda, *A test of self-determination theory in exercise domain*. J Appl Soc Psychol, 2006. 36: p. 2240-2265.
2. Edmunds, J., N. Ntoumanis, and J. Duda, *Understanding exercise adherence and psychological well-being from a self determination theory perspective among a cohort of obese patients referred to an exercise on prescription scheme*. Psychol Sport Exerc, 2007. 8: p. 722-740.
3. Edmunds, J., N. Ntoumanis, and J. Duda, *Testing a selfdetermination theory-based teaching style intervention in the exercise Domain*. Eur J Soc Psychol, 2008. 38: p. 375-388.
4. Pelletier, L.G., M.S. Fortier, R.J. Vallerand, and N.M. Briere, *Associations among perceived autonomy support, forms of self-regulation, and persistence: a prospective study*. Mot Emot, 2001. 25(4): p. 279-306.
5. Fortier, M.S., S.N. Sweet, T.L. O'Sullivan, and G. Williams, *A self-determination process model of physical activity adoption in the context of a randomized controlled trial*. Psychol Sport Exerc, 2007. 8: p. 741-757.
6. Williams, G.C., V.M. Grow, Z.R. Freedman, R. Ryan, and E. Deci, *Motivational predictors of weight loss and weight-loss maintenance*. J Person Soc Psychol, 1996. 70(1): p. 115-26.
7. Williams, G.C., D.S. Minicucci, R.W. Kouides, C.S. Levesque, V.I. Chirkov, R. Ryan, and E. Deci, *Self-determination, smoking, diet and health*. Health Ed Res, 2002. 17(5): p. 512-21.
8. Wilson, P. and W. Rodgers, *The relationship between perceived autonomy support exercise regulations and behavioural intentions in women*. Psychol Sport Exerc, 2003. 5: p. 229-242.
9. Wilson, P., W.M. Rodgers, S.N. Fraser, and T.C. Murray, *Relationships between exercise regulations and motivational consequences in university students*. Res Quart Exerc Sport, 2004. 75(1): p. 81-91.

10. Hagger, M. and N. Chatzisarantis, *Self-determination theory and the psychology of exercise*. *Inter Rev Sport Exerc Psychol*, 2008. 1: p. 79-103.
11. Baranowski, T., C. Anderson, and C. Carmack, *Mediating variable framework in physical activity interventions. How are we doing? How might we do better?* *Am J Prev Med*, 1998. 15(4): p. 266-97.
12. Williams, G.C., M. Gagne, R. Ryan, and E. Deci, *Facilitating autonomous motivation for smoking cessation*. *Health Psychol*, 2002. 21(1): p. 40-50.
13. Williams, G.C., H.A. McGregor, D. Sharp, C. Levesque, R.W. Kouides, R. Ryan, and E. Deci, *Testing a self-determination theory intervention for motivating tobacco cessation: supporting autonomy and competence in a clinical trial*. *Health Psychol*, 2006. 25(1): p. 91-101.
14. Wilson, P., D. Mack, and K. Grattan, *Understanding Motivation for Exercise: A Self-Determination Theory Perspective*. *Can Psychol*, 2008. 49(3): p. 250-256.
15. Hagger, M. and N. Chatzisarantis, *Self-determination theory and the psychology of exercise*. *Intern Rev Sport Exerc Psychol*, 2008. 1: p. 79-103.
16. Deci, E. and R. Ryan, *The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior*. *Psychol Inquiry*, 2000. 11(4): p. 227–268.
17. Deci, E. and R. Ryan, *Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health*. *Can Psychol*, 2008. 49(3): p. 182–185.
18. Williams, G.C. and E. Deci, *Activating patients for smoking cessation through physician autonomy support*. *Med Care*, 2001. 39(8): p. 813-23.
19. Williams, G.C., H.A. McGregor, A. Zeldman, Z.R. Freedman, and E. Deci, *Testing a self-determination theory process model for promoting glycemic control through diabetes self-management*. *Health Psychol*, 2004. 23(1): p. 58-66.
20. Saris, W.H., S.N. Blair, M.A. van Baak, S.B. Eaton, P.S. Davies, L. Di Pietro, M. Fogelholm, A. Rissanen, D. Schoeller, B. Swinburn, A. Tremblay, K.R. Westerterp, and H. Wyatt, *How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement*. *Obes Rev*, 2003. 4(2): p. 101-14.
21. Donnelly, J.E., S.N. Blair, J.M. Jakicic, M.M. Manore, J.W. Rankin, and B.K. Smith, *American College of Sports Medicine Position Stand. Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults*. *Med Sci Sports Exerc*, 2009. 41(2): p. 459-71.

22. Donnelly, J.E., B. Smith, D.J. Jacobsen, E. Kirk, K. Dubose, M. Hyder, B. Bailey, and R. Washburn, *The role of exercise for weight loss and maintenance*. Best Practices Res Clin Gastr, 2004. 18(6): p. 1009-29.
23. Legault, L., I. Green-Demers, and A.L. Eadie, *When internalization leads to automatization: The role of self-determination in automatic stereotype suppression and implicit prejudice regulation*. Mot Emot, 2009. 33: p. 10-24.
24. Burton, K., J. Lydon, D. D'Alessandro, and R. Koestner, *The differential effects of intrinsic and identified motivation on well-being and performance: prospective, experimental, and implicit approaches to self-determination theory*. J Person Soc Psychol, 2006. 91(4): p. 750-762.
25. Kraemer, H.C., G.T. Wilson, C.G. Fairburn, and W.S. Agras, *Mediators and moderators of treatment effects in randomized clinical trials*. Archiv Gen Psych, 2002. 59(10): p. 877-83.
26. Mata, J., M.N. Silva, P.N. Vieira, E.V. Carraca, A.M. Andrade, S.R. Coutinho, L.B. Sardinha, and P.J. Teixeira, *Motivational "spill-over" during weight control: Increased self-determination and exercise intrinsic motivation predict eating self-regulation*. Health Psychol, 2009. 28(6): p. 709-16.
27. Deci, E. and R. Ryan, *Intrinsic motivation and self-determination in human behavior*. 1985, New York: Plenum.
28. Elfhag, K. and S. Rossner, *Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain*. Obes Rev, 2005. 6(1): p. 67-85.
29. Teixeira, P.J., S.B. Going, L.B. Sardinha, and T.G. Lohman, *A review of psychosocial pre-treatment predictors of weight control*. Obes Rev, 2005. 6(1): p. 43-65.
30. Gorin, A.A., A. Pinto, D. West, H. Niemeier, J. Fava, and R.R. Wing, *Losing weight because you want to rather than because you feel you have to: Motivational predictors of weight loss outcomes*. Obes, 2008. 16: p. S214.
31. Puhl, R. and K.D. Brownell, *Bias, discrimination, and obesity*. Obes Res, 2001. 9(12): p. 788-805.
32. Ingledew, D., D. Markland, and E. Ferguson, *Three levels of exercise motivation*. Appl Psychol, 2009. 1: p. 336-355.
33. Ingledew, D. and D. Markland, *The role of motives in exercise participation*. Psychol Health, 2008. 23(7): p. 807 - 828.

34. Puhl, R.M., C.A. Moss-Racusin, and M.B. Schwartz, *Internalization of weight bias: Implications for binge eating and emotional well-being*. *Obes*, 2007. 15(1): p. 19-23.
35. Byrne, S., Z. Cooper, and C. Fairburn, *Weight maintenance and relapse in obesity: a qualitative study*. *Int J Obes Relat Metab Disord*, 2003. 27(8): p. 955-62.
36. Ogden, J., *The correlates of long-term weight loss: a group comparison study of obesity*. *Int J Obes Relat Metab Disord*, 2000. 24(8): p. 1018-25.
37. Kayman, S., W. Bruvold, and J.S. Stern, *Maintenance and relapse after weight loss in women: behavioral aspects*. *Am J Clin Nutr*, 1990. 52(5): p. 800-7.
38. Deci, E. and R. Ryan, *Facilitating Optimal Motivation and Psychological Well-Being Across Life's Domains*. *Can Psychol*, 2008. 49(1): p. 14-23.
39. Sebire, S.J., M. Standage, and M. Vansteenkiste, *Development and validation of the goal content for exercise questionnaire*. *J Sport Exerc Psychol*, 2008. 30(4): p. 353-77.
40. Baumeister, R.F., T.F. Heatherton, and D.M. Tice, *Losing control: How and why people fail at self-regulation*. 1994, New York: Academic Press.
41. Baumeister, R.F., E. Bratslavsky, M. Muraven, and D.M. Tice, *Ego depletion: is the active self a limited resource?* *J Pers Soc Psychol*, 1998. 74(5): p. 1252-65.
42. Moller, A.C., E.L. Deci, and R.M. Ryan, *Choice and ego-depletion: the moderating role of autonomy*. *Pers Soc Psychol Bull*, 2006. 32(8): p. 1024-36.
43. Wilson, P., D. Mack, C. Blanchard, and C. Gray, *The role of perceived psychological need satisfaction in exercise-related affect*. *Hellenic J Psychol*, 2009. 6: p. 183-206.
44. Wilson, P., K. Longley, S. Muon, T. Murray, and W. Rodgers, *Examining the Contributions of Perceived Psychological Need Satisfaction to Well-Being in Exercise*. *J Appl Biobehav Res*, 2006. 11(3-4): p. 243-264.
45. Gagné, M., R. Ryan, and K. Bargmann, *Autonomy Support and Need Satisfaction in the Motivation and Well-Being of Gymnasts*. *J Appl Sport Psychol*, 2003. 15: p. 372-390.
46. Isen, A.M. and K.A. Daubman, *The influence of affect on categorization*. *J Person Soc Psychol*, 1984. 47: p. 1206-1217.
47. Isen, A.M., K.A. Daubman, and G.P. Nowicki, *Positive affect facilitates creative problem solving*. *J Pers Soc Psychol*, 1987. 52(6): p. 1122-31.
48. Rhodes, R.E., B. Fiala, and M. Conner, *A review and meta-analysis of affective judgments and physical activity in adult populations*. *Ann Behav Med*, 2009. 38(3): p. 180-204.

49. Ekkekakis, P., *Affect circumplex redux: The discussion on its utility as a measurement framework in exercise psychology continues*. Intern Rev Sport Exerc Psychol, 2008. 1: p. 139-159.
50. Warburton, D.E., P.T. Katzmarzyk, R.E. Rhodes, and R.J. Shephard. *Evidence-based guidelines for physical activity of adult Canadians*. Appl Physiol Nutr Metab, 2007. 32 (2F): p. S17-74.
51. Hall, P.A. and G.T. Fong, *Temporal self-regulation theory: A model for individual health behavior*. Health Psychol Rev, 2007. 1: p. 6-52.
52. Palmeira, A., P.J. Teixeira, D. Markland, M.N. Silva, T. Branco, S. Martins, C. Minderico, J. Barata, S. Serpa, and L.B. Sardinha, *Reciprocal mediated effects of changes in weight and psychological factors, in a behavioral weight loss treatment*. Int J Behav Nutr Phys Act, 2009. 6(9).
53. Markland, D., *The mediating role of behavioural regulations in the relationship between perceived body size discrepancies and physical activity among adult women*. Hellen J Psychol, 2009. 6: p. 169-182.
54. Powell, L., J. Calvin III, and J. Calvin jr., *Effective obesity treatments*. Am Psychol, 2007. 62(3): p. 234-246.
55. Perri, M. and P. Fuller, *Success and failure in the treatment of obesity: Where do we go from here?* Med Exerc Nut Health, 1995. 4: p. 255-272.
56. Perri, M. and J. Corsica, *Improving the maintenance of weight-loss in behavioral treatment of obesity*, in *Handbook of obesity treatment*, T.A. Wadden and A. Stunkard, Editors. 2002, Guilford Press: New York.
57. Kruger, J., H.M. Blanck, and C. Gillespie, *Dietary and physical activity behaviors among adults successful at weight loss maintenance*. Int J Behav Nutr Phys Act, 2006. 3: p. 17.
58. Rollnick, S., W. Miller, and C. Butler, *Motivational Interviewing in Health Care: Helping Patients Change Behavior*. 2007: Guilford Publications.
59. Miller, W.R. and G.S. Rose, *Toward a theory of motivational interviewing*. Am Psychol, 2009. 64(6): p. 527-37.
60. Eurobarometer, *Sport and Physical Activity*. 2010, 334 / Wave 72.3: TNS Opinion & Social.

61. Knowler, W.C., E. Barrett-Connor, S.E. Fowler, R.F. Hamman, J.M. Lachin, E.A. Walker, and D.M. Nathan, *Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin*. N Engl J Med, 2002. 346(6): p. 393-403.
62. Michie, S. and C. Abraham, *Interventions to change health behaviours: evidence-based or evidence-inspired?* Psychol Health, 2004. 19: p. 29-49.

APPENDICES

**Other articles (in Portuguese)
published within the context of
P.E.S.O study**

Programa P.E.S.O. - Promoção do Exercício e Saúde na Obesidade: Metodologia e Descrição da Intervenção⁵

⁵ Silva, M.N., Teixeira, P.J., Vieira, P.N., Minderico, C.S., Castro, Coutinho, S.R., Carraça, E., Marcelino, M., Santos, T.C., Sardinha, L.B (2007) Programa P.E.S.O. - Promoção do Exercício e Saúde na Obesidade: Metodologia e Descrição da Intervenção. *Endocrinologia, Diabetes & Obesidade*.1 (1): 17-28

RESUMO

Este artigo descreve o Programa PESO (Promoção do Exercício e Saúde na Obesidade), desenvolvido no Laboratório de Exercício e Saúde da Faculdade de Motricidade Humana e que envolve um estudo experimental prospectivo controlado, com distribuição aleatória por grupos. A intervenção é faseada em 3 “cohorts”, para um total de participantes de 300. Cada “cohort”, com aproximadamente 100 participantes, divide-se em dois grupos constituídos aleatoriamente: Grupo Experimental (50 participantes) e Grupo de Controlo (50 participantes). O Grupo Experimental é submetido ao Programa de Intervenção Principal. O Grupo de Controlo tem acesso a um programa educacional para a melhoria da saúde geral, desenvolvido por motivos de ordem ética e como estratégia de prevenção do atrito. A Intervenção Principal consiste em 30 reuniões semanais ou bimensais de 90-120 minutos, ao longo de 10 meses, para 23-25 mulheres por subgrupo, estruturada com base em tópicos centrais para a perda de peso, nomeadamente o balanço energético, promoção da AF, alterações qualitativas/quantitativas da alimentação, a mudança comportamental, entre outras. A intervenção principal é baseada em princípios teóricos e aplicações práticas pré-definidas (Teoria da Auto-Determinação) e os tópicos são abordados num clima de promoção da competência pessoal e da autonomia, incentivando a adopção de comportamentos passíveis de serem integrados no estilo de vida de forma a serem mantidos no longo prazo. Descreve-se em detalhe neste trabalho o enquadramento conceptual, os objectivos, o desenho experimental e a metodologia deste estudo, o primeiro em Portugal com estas características.

Palavras-chave: Obesidade, actividade física, alimentação, tratamento, intervenção, mediadores

ABSTRACT

The purpose of this article is to describe the PESO program (Promotion of Exercise and Health in Obesity), developed in the Laboratory of Exercise and Health (Faculty of Human Movement) and based on a randomized controlled trial (RCT). The intervention is delivered in 3 successive cohorts for approximately 300 overweight or obese women. Approximately 100 participants in each cohort were randomly assigned to experimental (50) and control groups (50). The experimental group is submitted to main intervention program. Controls receive a general health education curriculum based on health education topics, developed for ethical reasons and for attrition prevention. The main intervention program includes 30 group meetings lasting 90-120 minutes, for 10 months, with 23-25 women per class, covering most topics considered critical for successful weight control (physical activity, eating/nutrition, behavior change). These topics and especially their delivery were adapted to comply with Self-Determination-Theory tenets. Autonomy, intrinsic motivation, and self-regulation for behavior change are central intervention targets. Accordingly, autonomy-supportive treatment climate and internal causality orientations are hypothesized to enhance autonomous regulation, perceived competence, self-efficacy, and intrinsic motivation, resulting in lasting behavioural changes. This paper provides a detailed description of the study's conceptual framework, primary objectives, research design, and methodology, the first of this kind to be implemented in Portugal.

Key-Words: Obesity, physical activity, eating/nutrition, treatment, intervention, mediators

Enquadramento Teórico

A prática de actividade física (AF), pelos benefícios comprovados a nível fisiológico e psicológico, é hoje um tema central no âmbito do controlo do peso. Após determinados estes benefícios, importa identificar os factores relacionados com a sua promoção (1), particularmente no âmbito da obesidade, pois embora o estudo das determinantes da AF esteja avançado para outras populações, é relativamente inovador na população obesa (2). A obesidade constitui hoje uma grave ameaça para a saúde pública pela sua ligação à doença crónica e comprometimento da qualidade de vida. Se não se tomarem medidas eficazes de combate, projecta-se que, em 2025, mais de 50% da população mundial seja obesa, reconhecendo-lhe a Organização Mundial de Saúde as características de pandemia (3). Também a realidade Portuguesa está a tornar-se preocupante. O mais recente estudo ao nível da prevalência da obesidade em Portugal (4) verificou que mais de metade da população portuguesa apresenta um peso superior ao desejável (51.6%), dos quais cerca de 15% são pessoas obesas (IMC superior a 30 kg/m²). Sendo uma situação crónica, a obesidade exige uma abordagem terapêutica que induza mudanças para toda a vida. Embora se reconheça o papel de factores genéticos, uma elevada parcela de responsabilidade está associada a índices inadequados de actividade física aliados a dietas incorrectas, pelo que a elaboração de programas de controlo de peso baseados nestes comportamentos é parte integrante da solução actualmente indicada como a mais apropriada (5). Segundo as recomendações do National Institutes of Health (6) o tratamento da obesidade ou excesso ponderal deve incluir exercício regular, restrição calórica e modificação comportamental. A nível nacional, no Relatório de Consenso publicado em 2001, a Sociedade Portuguesa para o Estudo da Obesidade (SPEO) defende que a alteração dos hábitos alimentares e a adopção de um estilo de vida que inclua o aumento do grau de actividade física e uma perspectiva comportamental são fundamentais e divergem do “tratamento milagre” a curto prazo (7). Não obstante tais constatações, e embora

esteja bem estudada a dose eficaz de actividade física que promove a perda e/ou a manutenção do peso (8), permanece por resolver o problema da promoção de níveis de adesão consentâneos com objectivos de saúde pública (dose eficiente ou aplicável), sendo que as estratégias de prescrição de dose eficaz não parecem suficientes (9). De facto, apesar de estar bem documentado o papel protector da saúde deste comportamento, a sua adopção mantém-se baixa e difícil de promover. Apesar da concorrência de variados factores causais, a componente motivacional desempenha um papel fundamental pelo que a sua compreensão e promoção são tarefas fundamentais (10).

Biddle (11) sugere que os modelos que melhor explicam a adopção de um estilo de vida activo são os centrados na percepção de competência pessoal, autonomia e auto-eficácia, destacando o conceito de “auto-determinação”. É actualmente consensual que sujeitos mais auto-determinados para a AF têm intenções mais fortes e realizam mais AF que sujeitos com motivos externos (12). Tais considerações ancoram na Teoria da Auto-Determinação (TAD), (13) que introduziu a ideia de contínuo entre motivação intrínseca (autónoma) e extrínseca (controlada). A motivação é autónoma quando o indivíduo age voluntariamente, de acordo com a sua escolha, valorização e objectivos próprios. Contrariamente, a motivação será controlada na medida em que é condicionada por pressões e recompensas internas ou externas. É proposto que o tipo de auto-regulação adoptada determina a adesão continuada do comportamento de saúde e que, através da manipulação de factores contextuais ou situacionais, sustentados por intervenções específicas, pode mover-se os indivíduos da regulação externa e controlada até à regulação integrada e autónoma (14). Em mulheres obesas, verificou-se recentemente que o aumento da motivação intrínseca para o exercício foi o preditor mais forte da perda de peso a longo prazo (15). A alteração inicial da motivação intrínseca para o exercício, nomeadamente o aumento das sensações de prazer, auto-eficácia e competência na actividade física surgiram como preditores significativos da perda de peso no

longo prazo, resultados que confirmaram estudos anteriores acerca do poder explicativo de variáveis da TAD no sucesso na perda de peso e adoção de actividade física.

A necessidade de desenvolver programas de modificação comportamental realmente eficazes decorre da constatação de que a maioria dos modelos teóricos actualmente aplicados à mudança de comportamentos de saúde a longo prazo não o têm conseguido fazer satisfatoriamente (16). De facto, várias teorias (p.ex., “Teoria das Crenças de Saúde”, “Teoria do Comportamento Planeado”) têm revelado utilidade na explicação/promoção da intenção de se ser fisicamente activo em pessoas inicialmente sedentárias. A TAD pode ajudar na implementação continuada dessas intenções no longo prazo, algo particularmente pertinente, não só pela necessidade enunciada de desenvolver programas realmente eficazes no longo prazo, mas também decorrente da constatação de que a maioria das teorias identificando determinantes psicológicos dos comportamentos de saúde não geram intervenções em termos da alteração de comportamento. Esta é uma situação que a TAD permite ultrapassar pela sua aplicação demonstrada ao campo prático da intervenção. A questão da qualidade das intervenções, permitindo a obtenção de resultados baseados na evidência, também é defendida por Michie & Abraham (2004), afirmando que, para a atingir, qualquer estudo baseado num Programa de Intervenção deve fornecer explicações válidas ao nível dos resultados do mesmo, procurando perceber se o programa funciona (quando aplicado produz alterações mensuráveis relativamente a um grupo de controlo?), qual o seu impacto em termos da magnitude dos seus efeitos, como funciona e para quem funciona.

A importância do estudo das variáveis moderadoras e mediadoras

Ao nível da resposta às duas últimas questões, sublinha-se a importância da identificação de variáveis moderadoras e mediadoras (17). Um mediador dos resultados de um programa refere-se a um processo que ocorre durante o tratamento (“como”), presumivelmente como

efeito da participação naquele programa específico, responsável por determinada percentagem da variância num determinado resultado. Só através da identificação e descrição dos mecanismos críticos de mudança podem investigadores e clínicos aumentar a eficácia e aplicabilidade dos programas, mas também aumentar o conhecimento dos aspectos fulcrais à manutenção e persistência do comportamento inadequado (ex. sedentarismo), aumentando também o conhecimento dos mecanismos envolvidos. Um moderador dos resultados de um programa prende-se sobretudo com a resposta à questão de investigação “Para quem?”. Trata-se, portanto, de variáveis que representam características individuais (ou outras) presentes à partida (antes da intervenção) e que estarão associadas com melhores/piores resultados, independentemente da (ou de forma interactiva com a) modalidade de tratamento utilizada. Atendendo à grande variabilidade inter-individual nos resultados de participantes em programas de tratamento da obesidade, identificar variáveis potencialmente explicativas do sucesso é um objectivo prioritário nesta área de estudos (2).

A investigação centrada nestes dois tipos de variáveis – moderadoras e mediadoras – que, no seu conjunto, se denominam variáveis preditoras, está de acordo com a orientação defendida por alguns investigadores (18). Esta assenta no pressuposto fundamental de que um programa de intervenção poderá originar mudanças comportamentais porque existiram alterações em variáveis mediadoras e/ou porque determinados elementos moderadores estavam presentes à partida. É importante considerar-se que as intervenções não têm geralmente um efeito directo no comportamento das pessoas mas sim um efeito indirecto, através da sua influência em factores mediadores. Ou seja, o profissional de saúde procura afectar as condicionantes internas (motivação, competências) ou externas (oportunidades) que estimulem e/ou permitam ao utente a tomada de decisão autónoma. Por isso é fundamental identificar os factores passíveis de serem influenciados por intervenções.

São estes os pressupostos principais que estiveram na base da concepção do Programa PESO (Promoção do Exercício e Saúde na Obesidade), aplicação 2004-2009, que se apresenta neste trabalho.

Objectivos de Investigação

Objectivos Principais

1. Descrever e avaliar o impacto de um programa de intervenção comportamental para a perda e manutenção do peso, baseado nos princípios da TAD, na actividade física e exercício, relativamente a um grupo de controlo. As variáveis-alvo principais são a AF formal (exercício de intensidade moderada e vigorosa) e informal (marcha e outras actividades de intensidade ligeira e/ou integradas no estilo de vida);
2. Descrever e avaliar o impacto de um programa de intervenção comportamental para a perda e manutenção do peso, baseado nos princípios da TAD, no peso e composição corporal, relativamente a um grupo de controlo;
3. Descrever e avaliar o impacto de um programa de intervenção comportamental para a perda e manutenção do peso, baseado nos princípios da TAD, na motivação intrínseca para o exercício e variáveis relacionadas, relativamente a um grupo de controlo;
4. Identificar e descrever as características (variáveis moderadoras, avaliadas antes do programa) e processos (variáveis mediadoras, alterações durante o programa) individuais e de contexto ambiental associadas à maior ou menor perda/manutenção do peso em mulheres com excesso de peso, durante um programa de intervenção comportamental para a perda e manutenção do peso;

5. Identificar e descrever as variáveis moderadoras e variáveis mediadoras individuais e de contexto ambiental associadas à maior ou menor adesão a comportamentos de exercício e actividade física em mulheres com excesso de peso durante um programa de intervenção comportamental para a perda e manutenção do peso;

Objectivos Secundários

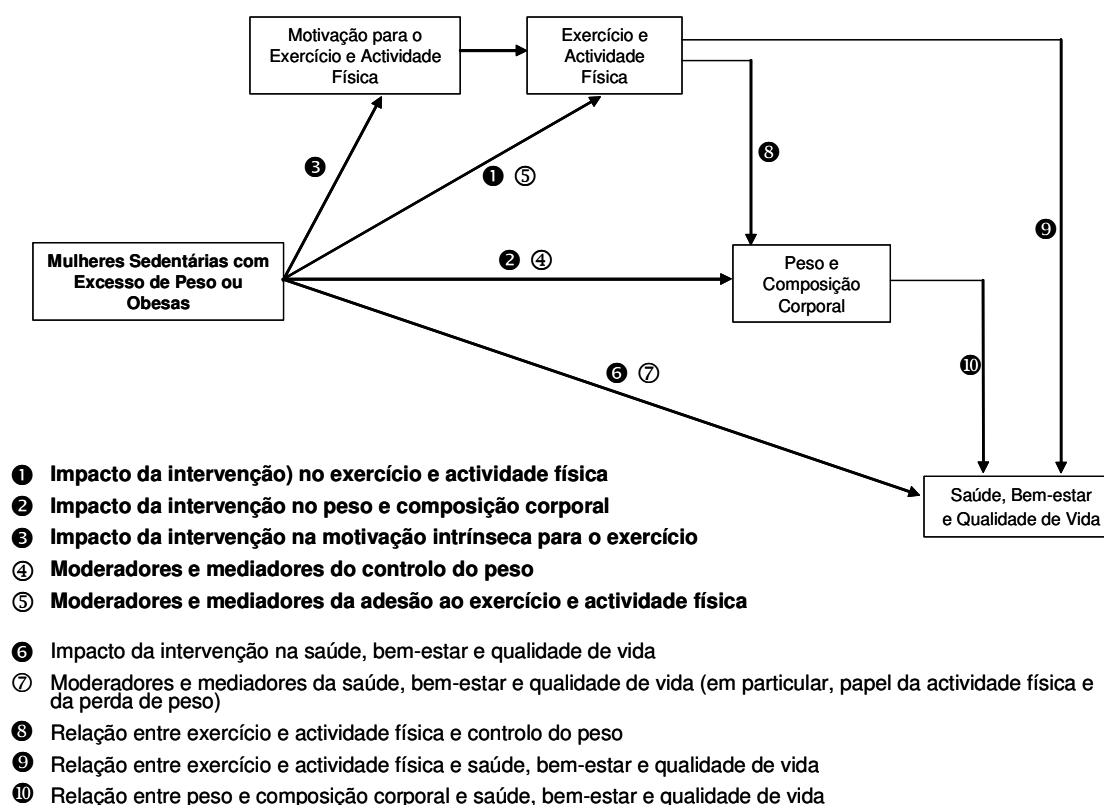
6. Avaliar o impacto um programa de intervenção comportamental para a perda e manutenção do peso, na saúde física e metabólica;

7. Identificar e descrever as variáveis moderadoras e variáveis mediadoras individuais e de contexto ambiental associadas ao maior ou menor aumento da saúde física e psicológica e da qualidade de vida, particularmente os efeitos interactivos e independentes da actividade física (9) e da perda de peso (10);

8. Avaliar a relação entre actividade física e exercício e alterações no peso e composição corporal.

Outros objectivos desta investigação existem, nomeadamente em relação à importância dos comportamentos alimentares e da nutrição, que serão descritos em outros trabalhos. A Figura 1 sistematiza as principais linhas de investigação em análise no presente artigo.

Figura 1: Principais Linhas de Investigação em Análise



MÉTODOS

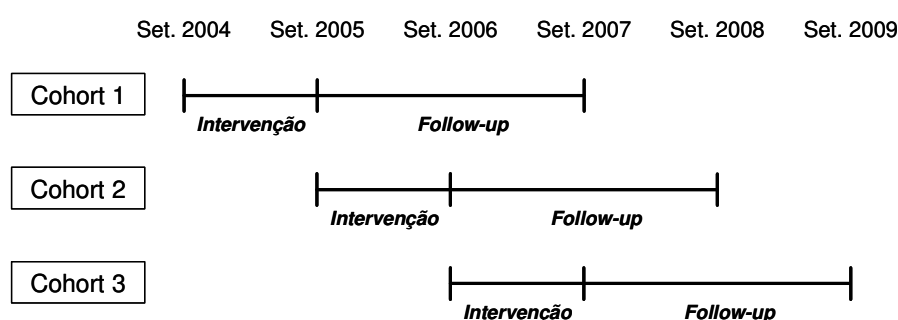
Desenho Experimental

Trata-se de um estudo prospectivo, experimental e controlado. Prospectivo porque se baseia numa caracterização dos sujeitos ao nível dos factores preditores iniciais, a que se segue um acompanhamento durante a intervenção onde se analisam as alterações das variáveis em estudo, procurando-se explicar os resultados obtidos. Experimental, porque há manipulação das variáveis e controlado pela existência de um grupo de controlo para além do grupo de intervenção principal, criados através de uma divisão por distribuição aleatória.

A estruturação temporal do estudo está representada na Figura 2, iniciando-se o programa com um primeiro ano de intervenção, seguido de dois anos de acompanhamento, sem contacto para além dos momentos de avaliação calendarizados. A intervenção é faseada em 3 “cohorts”, para um total de 250-300 participantes. Cada “cohort”, com aproximadamente 100

participantes, é dividido aleatoriamente nos dois grupos já referidos: Grupo de Intervenção (aproximadamente 50 participantes) e Grupo de Controlo (aproximadamente 50 participantes). O Grupo de Intervenção é submetido ao Programa de Intervenção Principal. O Grupo de Controlo tem acesso a um programa educacional para a melhoria da saúde geral (mini-cursos de nutrição preventiva e segurança alimentar, valorização pessoal, relaxação e palestras com convidados especiais), desenvolvido por motivos de ordem ética e como estratégia de prevenção do atrito.

Figura 2: Estruturação Temporal do Estudo



O Programa PESO decorre nas instalações da Faculdade de Motricidade Humana e é levado a cabo por uma equipa multidisciplinar de técnicos especialistas do Laboratório de Exercício e Saúde (nutricionistas, fisiologistas do exercício e psicólogos em programas de mestrado, doutoramento e pós doutoramento), procurando cumprir com o respeito pelos 4 indicadores de rigor metodológico (19) para ensaios clínicos experimentais com intervenção, nomeadamente: a presença de um grupo de controlo obtido aleatoriamente; a existência de dados dos períodos pré e pós intervenção; a manutenção de uma base de dados de atrito e; a procura de resultados ao nível dos principais construtos que são objecto de intervenção.

Recrutamento e selecção da amostra

As participantes são recrutadas através de anúncios divulgados nos media (televisão, revistas, jornais, rádio), convites enviados para diversos list-servers, posters e flyers afixados em diversos serviços e iniciativas de saúde, e através de um site desenvolvido especificamente para dar apoio ao Programa PESO (p.ex., descrição, divulgação de recrutamento, cursos, marcação de avaliações), acessível em <http://peso.fmh.utl.pt>. Todas as pessoas interessadas e que cumpram os critérios de inclusão são convidadas a participar em uma de várias reuniões de recrutamento onde o Programa PESO, a sua filosofia e a sua estruturação são explicados em pormenor e as dúvidas esclarecidas.

Crítérios de Inclusão

São seleccionadas para o estudo todas as mulheres que, reunindo as condições de participação requeridas, se disponibilizam a participar. São critérios de inclusão e exclusão: ser do sexo feminino e ter entre 25 e 50 anos; situação de pré menopausa; IMC entre 25 kg/m² e 40 kg/m²; disponibilidade para estar presente nas sessões semanais de intervenção (1º ano); disponibilidade para estar presente em todos os momentos de avaliação calendarizados; não estar grávida nem planear estar nos próximos 2 anos; não existir quadro clínico grave ou limitativo; não estar a tomar medicação que interfira com a regulação do peso; não participar em nenhum outro programa de controlo de peso (durante o primeiro ano, para as participantes do grupo de intervenção); não participar em nenhum outro programa de controlo de peso que envolva medicação ou cirurgia (para as participantes do grupo de controlo).

A escolha desta população prende-se com a necessidade de uma amostra relativamente homogénea, com preocupações de dar continuidade a estudos anteriores neste grupo, com a grande procura que se verifica no sexo feminino para soluções para o controlo de peso, e com evidência de que a etapa do ciclo de vida visada (25-50 anos) envolve importantes adaptações

comportamentais e fisiológicas que tendem a reflectir-se no ganho progressivo de peso (20). Em Portugal, este é também um período de muito rápido aumento de peso corporal no sexo feminino (21).

Intervenção Principal

Objectivos

O Programa PESO pretende promover alterações estáveis dos hábitos e estilos de vida das participantes. Baseando-se na constatação fundamental de que, no início de qualquer processo de mudança, é essencial definir e partilhar objectivos claros, para que todos os intervenientes conheçam as metas a atingir e também para seja possível monitorizar o progresso ao longo do tempo, são apresentados como objectivos a atingir pelas participantes até ao final do Programa, as seguintes metas:

- Assistir a pelo menos 90% das sessões;
- Evitar o ganho de peso durante a duração do programa e preferencialmente atingir uma redução de 5-10% do peso inicial aos 12 meses (ou superior);
- Manter uma redução mínima de 5% do peso inicial aos 24 meses e 36 meses;
- Aumentar a actividade física no dia-a-dia (atingir 10.000 passos diários sempre que possível) e acumular 30 minutos ou mais de exercício, no mínimo de intensidade moderada, na maioria dos dias da semana;
- Melhorar a qualidade nutricional da sua alimentação e reduzir 300-500 calorias diárias em comparação com o ingerido no início do programa;
- Conseguir uma redução de peso prioritariamente constituída por massa gorda (mais de 80% do peso perdido);

- Aumentar o conhecimento sobre tópicos essenciais no controlo do peso, tais como nutrição, actividade física, equilíbrio energético, consequências para a saúde da obesidade, e o impacto do meio ambiente físico e sócio-cultural;
- Abandonar a procura de controlo externo, desenvolvendo uma postura mais autónoma acerca da gestão do peso e respectivas influências e responsabilizando-se pelas suas escolhas e comportamentos;
- Desenvolver competências específicas e hábitos de auto-monitorização do processo individual de controlo de peso (monitorização do peso, alimentação, actividade física, estado emocional);
- Adoptar uma atitude de maior envolvimento não só no Programa como na vida diária, potenciando resultados positivos ao nível da qualidade de vida, saúde mental, bem-estar e auto-estima.

Formato

A Intervenção Principal consiste em 30 reuniões semanais ou bimensais, ao longo de 10-12 meses, para cerca de 25 mulheres por subgrupo ou classe. A divisão em grupos desta dimensão visa o estabelecimento de dinâmicas enriquecedoras, com empatia e frequente troca de experiências. Cada sessão, com cerca de 2 horas, é constituída por um check-in, permitindo o balanço dos acontecimentos até ao momento, promovendo a componente experiencial, por um corpo teórico principal, abordando questões centrais aos objectivos em questão, sempre da forma dinâmica e interactiva, e finalmente por um check out, configurando a pesagem (periodicamente supervisionada) e tarefas de índole administrativa.

As sessões são estruturadas com base em tópicos fundamentais para a perda de peso (balanço energético, promoção da actividade física, alterações qualitativas/quantitativas da alimentação, etc.), melhoria da imagem corporal, divulgados num clima de promoção e

suporte da competência pessoal e da autonomia, incentivando a adopção de comportamentos passíveis de serem integrados no estilo de vida. Periodicamente ocorrem sessões em formato de workshop, visando competências específicas a desenvolver (p.ex., resolução de problemas, imagem corporal). A prática de actividade física e exercício é também contemplada, sendo organizadas caminhadas, sessões na sala de exercício da FMH, aulas demonstrativas de algumas modalidades de grupo, entre outras. O principal objectivo destas sessões, que são em número reduzido, é aumentar nas participantes o conhecimento de opções disponíveis para a prática, aumentar a sua competência para o exercício, e motivar as participantes para procurarem, no contexto das suas vidas, implementar a sua própria rotina de actividade física. Seguindo a estratégia definida, o foco é sempre colocado na iniciativa, interesse e autonomia da participante, tendo sido desenvolvido um Manual especificamente para o efeito, distribuído em fascículos nas sessões, para que as participantes possam acompanhar aprofundar os conteúdos tratados nas sessões.

Conteúdos

A Intervenção Principal incide em 3 áreas fundamentais na problemática do controlo do peso: actividade física, alimentação e plano cognitivo-comportamental, abordados de forma integrada e integradora, no sentido de se atingirem alterações, moderadas mas sustentadas, no padrão de alimentação e actividade física, conducentes a um balanço energético adequado.

Actividade física. Para além das questões do equilíbrio energético, são abordados tópicos como desenvolver e implementar um plano de exercício/AF formal no sentido de aumentar o dispêndio calórico em cerca de 1000 kcal/semana (início) até um mínimo de 1500-2000 kcal/semana (final do programa); como promover o aumento da actividade física diária (informal) de forma integrada no estilo de vida; possibilidades disponíveis para a prática na comunidade e na Natureza; benefícios e riscos da actividade física; uso correcto dos

equipamentos e vestuário e outras questões de segurança; como auto-monitorizar a intensidade do exercício (p.ex., frequência cardíaca, escala subjectiva de esforço); instruções para o uso de pedómetros, sua calibração e interpretação, entre muitos outros.

É colocado particular ênfase no trabalho de auto-monitorização e de confronto com possíveis barreiras para a prática: falta de tempo, condições atmosféricas adversas, falta de oportunidades, bem como a importância da escolha face à variedade oferecida. Este último tópico assume-se como fundamental. A possibilidade e variedade de escolhas disponíveis é promovida de forma estimuladora e desafiante, procurando-se apresentar às participantes um leque alargado de possibilidades disponíveis, incentivando-se a procura do prazer na prática da modalidade escolhida. Tal cuidado prende-se com a evidência, denotada pelo modelo teórico da investigação, de que os motivos extrínsecos podem levar à adopção inicial de actividade física, mas são os motivos intrínsecos que explicam o seu sucesso a longo prazo. Para ser possível atingir consistência comportamental no longo prazo, é fundamental promover o desenvolvimento de motivos mais auto-determinados. É assim central que as participantes se envolvam em actividades que sejam intrinsecamente motivadoras, agradáveis e valorizadas pessoalmente (bem integradas) e não externamente controladas.

Alimentação e Nutrição. No sentido de se atingir uma melhoria ao nível da qualidade e quantidade das calorias ingeridas, várias sessões abordam tópicos fundamentais da nutrição, no sentido de aumentar a informação e conhecimentos das participantes a este nível, desmistificando ideias erradas e conduzindo a escolhas mais informadas e sustentadas. São abordadas questões ligadas à composição nutricional e energética dos alimentos, redução da gordura e energia na alimentação, aumento dos factores de saciedade na dieta, redução do índice glicémico, importância do planeamento e fraccionamento alimentar, redução dos tamanhos das porções habituais, distinção entre fome física e emocional e uso da escala da fome, perigos e prevenção da alimentação emocional, planeamento das escolhas em ocasiões

especiais (férias, festas), dicas para comer fora de casa, sugestões de culinária e preparação dos alimentos, aprendizagem de leitura de rótulos, entre outros.

Plano cognitivo-comportamental. Ao longo do Programa são esperadas dificuldades específicas relacionadas com o processo de mudança ao nível da adopção de actividade física e alimentação adequada. Identificá-las e desenvolver ferramentas para as ultrapassar são prioridades da intervenção, através de:

Aumento do Conhecimento: Considerado um componente essencial a promover ao nível das duas áreas fundamentais, a promoção da informação visa o aprofundamento da compreensão de aspectos fundamentais para o controlo do peso. Baseia-se no pressuposto de que, antes de qualquer mudança, há que promover a compreensão do seu objectivo e fundamento, permitindo a escolha sustentada, livre e informada, fulcral para o sentimento de autonomia e de competência face à acção: saber o que escolher, porque escolher e como colocar em prática eficazmente.

Barreiras e Motivação: A questão motivacional é assumida como a pedra-chave de todo o processo, servindo os check-in e as dinâmicas interactivas para aceder a possíveis barreiras e dificuldades específicas, permitindo identificá-las e progressivamente ultrapassá-las. São ferramentas essenciais a este nível:

Auto-Monitorização: Particular ênfase é dado à auto-monitorização (alimentação, AF, peso), enquanto ferramenta a utilizar e integrar, permitindo tornar consciente e identificável o automático, sendo possível identificar padrões de comportamento e níveis de desempenho.

Resolução de Problemas: Promoção de competências ao nível da resolução de problemas (método dos 6 passos), procurando-se promover a capacidade e autonomia das participantes para fazerem face a problemas específicos que coloquem entraves à mudança e sua manutenção.

Percepção de Auto-eficácia: Definição de objectivos concretos e realistas, passíveis de serem monitorizados e alcançados, pela apresentação de testemunhos de sucesso, encorajando as participantes de grupos anteriores (casos de sucesso) a servirem de testemunho a ao grupo actual, trabalhando-se também o desenvolvimento de planos de contingência que permitam antecipar situações críticas.

Suporte Social: Estímulo à procura de apoio e envolvimento de outros significativos (cônjuges, filhos, amigos, familiares) e criação de um grupo de pessoas que conseguiram alcançar sucesso em programas anteriores cuja presença nas sessões e organização de actividades é solicitada.

Desenvolvimento de um sistema de recompensas pessoais: No desenvolvimento deste sistema é estimulado o reforço do comportamento pela antecipação de recompensas intrínsecas (p.ex., satisfação pela participação, sensação de bem-estar, aumento da auto-estima), sempre tendo em conta a individualidade de cada participante, os seus objectivos e interesses.

Melhoria da Imagem Corporal: Esta componente do programa visa a identificação e análise de distorções e insatisfações ao nível da imagem corporal. Estas são promovidas, muitas vezes, pela pressão externa e podem levar ao desenvolvimento de objectivos irrealistas que comprometem o processo de mudança. Neste sentido, o trabalho a desenvolver prende-se com a identificação das distorções como percepção selectiva e generalização abusiva, promovendo a reestruturação num clima de aceitação positiva e valorização de cada corpo como único. Pretende-se assim contribuir para a auto-aceitação a par do auto-conhecimento, no sentido da maior consciência de si, facilitadora da auto-regulação pretendida.

Manutenção do peso: Dada a crescente evidência científica de que a maioria do peso perdido em programas de perda de peso é recuperada no médio/longo prazo, evidencia-se a necessidade de desenvolvimento de componentes de intervenção especificamente estruturados

com vista à promoção de competências de manutenção do peso (22). Neste sentido, a última parte do programa incide no desenvolvimento de estratégias para otimizar a fase de manutenção, tais como: definição do padrão de peso a ser mantido; estabelecimento de um sistema de monitorização do peso, prático e passível de ser mantido; promoção do conhecimento e interpretação de alterações corporais; desenvolvimento de planos de contingência (saber quando e como agir de forma rápida).

Grupo de Controlo

Assumindo-se como um estudo controlado com distribuição aleatória por grupos, o Programa PESO faz uso de um grupo de controlo, sendo que, durante o primeiro ano, este não é alvo de nenhuma intervenção específica para o controlo de peso. Por motivos ligados à prevenção do atrito e também por razões éticas, são desenvolvidos mini-cursos (aproximadamente 10 sessões cada, com periodicidade quinzenal) de cariz educacional, com vista à promoção da saúde em geral. São exemplos um curso de alimentação saudável, um curso de relaxação e um curso de valorização pessoal. Este grupo tem ainda acesso a sessões magnas com convidados especiais e palestras, participando também em iniciativas e encontros que envolvam todas as participantes do peso (ex. mini-maratona, workshops de cozinha, etc.).

Avaliações

Este estudo faz uso de uma metodologia mista, qualitativa e quantitativa, procurando potenciar o aumento da informação disponível para análise:

- a) Avaliação do peso e da composição corporal e distribuição de gordura seguindo métodos de referência a este nível, nomeadamente antropometria e densitometria radiológica de dupla energia (DXA), avaliada por técnicos especializados;
- b) Actividade Física: Avaliada em situação ecológica real através de acelerometria (Actigraph AM256), permitindo aceder à AF total e dividida por categorias de intensidade; pedometria

(Yamax SW-200), permitindo a avaliação de passos/dia; e através da entrevista “7-day Physical Activity Recall” (7d PAR) e questionário “Obesity Physical Activity Recall” (Ob-PAR), estimando o tipo, duração e intensidade da AF;

c) Avaliação Psicológica: Aplicação de um amplo conjunto de instrumentos de avaliação psicológica, não só ao nível da caracterização psicossocial da amostra, como de construtos considerados relevantes na gestão do peso (Teixeira et al, 2005) nos domínios da história do peso e das dietas, comportamento alimentar (ex. restrição, alimentação emocional), estados psicológicos (ex. ansiedade, depressão), auto-estima, personalidade, imagem corporal, qualidade de vida, suporte social, entre outros. Para a análise dos diversos modelos teóricos associados à modificação comportamental destaca-se a avaliação de variáveis psicossociais provenientes do modelo teórico de referência, a TAD. Este oferece não só um enquadramento e modelo explicativo dos fenómenos motivacionais, nomeadamente no campo do exercício, mas também instrumentos específicos, testados e validados, para avaliar cada um dos seus construtos, como sejam as Orientações de Causalidade, o Locus de Causalidade, a Motivação Intrínseca, a Auto-Regulação, a Auto-Determinação, entre outros (23). A aplicação dos questionários é feita por baterias, em dias distintos para cada momento de avaliação, visando reduzir situações de cansaço e automatismo na resposta.

d) Nutrição e Alimentação: A avaliação da ingestão alimentar é conseguida através de diferentes métodos tais como um Questionário de Frequência Alimentar (método retrospectivo em formato de questionário de auto-preenchimento, no qual é registado a frequência de consumo, nos últimos meses, de várias categorias de alimentos similares nutricionalmente) e um Registo Alimentar de 3 dias (método prospetivo; auto-monitorização de toda a ingestão feita pela participante em contexto e tempo real) sendo este revisto na presença de um nutricionista (confirmação de quantidades, métodos de preparação etc.). A quantificação macro- e micro-nutricional é realizada através do software Food Processor

Software (SQL, versão 9.3). Paralelamente à ingestão alimentar, também os conhecimentos a este nível são avaliados através de um questionário de conhecimentos nutricionais.

e) **Metabolismo de Repouso:** Avaliado com uma tecnologia portátil de calorimetria indirecta de circuito aberto (Med Gem, Health-e-Tech, Inc, EUA), que determina o volume consumido de oxigénio. Pela utilização da equação de Weir e usando um Quociente Respiratório constante de 0,85. O valor do metabolismo de repouso (MR) é determinado pela formula metabolismo ($MR=6,931 \times \text{consumo de oxigénio}$). As participantes são avaliadas após um período de jejum nocturno (8-12 horas) entre as 7h00 e 10h00. O uso de estimulantes do sistema nervoso central, como a cafeína, o tabaco e medicação com esse efeito, bem como a prática de actividade física intensa, são excluídas no dia anterior ao teste.

f) **Entrevista Semi-Estruturada:** Especificamente desenvolvida para este estudo, com base em questões abertas e de duração de 45-50 minutos, é aplicada individualmente (antes e depois da intervenção principal) em condições standardizadas. O uso desta metodologia qualitativa é uma mais-valia importante deste estudo, permitindo o enriquecimento da informação disponível para análise e obviando algumas das limitações do uso exclusivo de questionários de auto-preenchimento.

A aplicação dos instrumentos seleccionados segue uma lógica idêntica para cada um dos 3 “cohorts” em estudo, sendo realizada no momento inicial, 4 meses, 12 meses, 16 meses, 24 meses e 36 meses. Os principais resultados de cada momento de avaliação, sistematizados por áreas, são devolvidos individualmente às participantes, através de um modelo de relatório especificamente definido para o efeito, numa lógica de promoção do auto-conhecimento e de monitorização do progresso.

Análise de Resultados

Todos os resultados decorrentes do estudo são registados em base de dados especificamente construída para o efeito, incluindo todos os registos, incluindo os das participantes desistentes. A análise de dados é feita para as participantes que concluírem o estudo (completers-only analysis) e também seguindo o princípio de análise intent-to-treat, em que todas as participantes que iniciaram o estudo são consideradas, de acordo com o método BOCF (Baseline Observation Carried Forward). Os dados qualitativos são submetidos a uma metodologia de análise de conteúdo com criação de categorias para posterior tratamento quantitativo. Os dados quantitativos são tratados segundo técnicas estatísticas adequadas utilizando o software SPSS (versão 15 ou versão mais actual disponível). De forma resumida, as técnicas estatísticas utilizadas são Medidas de Tendência Central e Dispersão; Correlação de Pearson ou Spearman (relacionamento bivariado linear entre predictores seleccionados e resultados observados); Regressão Linear Múltipla (associações multivariadas entre predictores e resultados); e Análise da Variância e Covariância com Medidas Repetidas (alterações longitudinais com comparações intra- e inter-grupos, controlando para os valores iniciais e outras variáveis relevantes).

DISCUSSÃO

Este artigo visa a descrição pormenorizada do Programa PESO (Promoção do Exercício e Saúde na obesidade) enquanto estudo de investigação científica, apresentando o seu racional enquadrador, objectivos, desenho experimental, metodologia e estruturação da intervenção principal. São pontos fortes deste estudo o desenho experimental controlado, a intervenção multifacetada intensiva (1 ano) com follow-up apropriado (mais 2 anos), a avaliação objectiva e ecológica da actividade física (acelerometria), a avaliação da composição corporal com métodos de referência e a avaliação sistemática e compreensiva de potenciais moderadores e mediadores (predictores ou determinantes) dos resultados. Através da sua implementação e análise de resultados, este projecto de investigação pretende contribuir, de forma

cientificamente sustentada, para o aumento do conhecimento, não só das variáveis envolvidas na alteração de comportamentos ligados à alimentação e actividade física conducentes a uma eficaz gestão do peso a longo prazo, como também permitir a testagem de um modelo específico de intervenção. Que seja do nosso conhecimento, trata-se do primeiro e do mais alargado ensaio clínico controlado de tratamento comportamental do excesso de peso e obesidade realizado em Portugal.

REFERÊNCIAS

1. Matos M, Calmeiro L. *Psicologia do Exercício e Saúde*. Azinhaga dos Ulmeiros: Visão e Contextos; 2004.
2. Teixeira PJ, Going SB, Sardinha LB, Lohman TG. A review of psychosocial pre-treatment predictors of weight control. *Obes Rev* 2005;6(1):43-65.
3. Chopra M, Darnton-Hill I. A global response to a global problem: the epidemic of overnutrition. *Bulletin World Health Organization* 2002;80(12):952-8.
4. Carmo I, Santos O, Camolas J, Vieira J, Carreira M, Medina L, et al. Prevalence of obesity in Portugal: preliminary results of a face-to-face survey. *Obesity Reviews* in press.
5. Wadden TA, Brownell KD, Foster GD. Obesity: responding to the global epidemic. *J Consult Clin Psychol* 2002;70(3):510-25.
6. USDHHS. *Clinical Guidelines on the identification, evaluation, and treatment of overweight and obesity in adults*: NIH-National Heart, Lung, and Blood Institute Bethesda, MD.; 1998.
7. SPEO. *Relatório de Consenso. Obesidade e sua terapêutica*: Sociedade Portuguesa para o Estudo da Obesidade; 2001.

8. Saris WH, Blair SN, van Baak MA, Eaton SB, Davies PS, Di Pietro L, et al. How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obes Rev* 2003;4(2):101-14.
9. Teixeira P, Silva M, Vieira P, Palmeira A, Sardinha L. A actividade física e o exercício no tratamento da obesidade. *Endocrinologia, Metabolismo e Nutrição* 2006;15(1).
10. Sheldon G, Williams G, Joiner T. *Self-determination theory in the clinic: motivating physical and mental health*. New Haven: Yale University Press; 2003.
11. Biddle S. What helps and hinders people becoming more physically active? In: A. Killoran PF, & C. Caspersen, editor. *Moving on International Perspectives Promoting Physical Activity*. London: HEA; 1994.
12. Biddle S, Nigg C. Theories of exercise behaviour. *International Journal of sport psychology* 2000; I 31:290-304.
13. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol* 2000;55(1):68-78.
14. Bidle S, Mutrie N. *Psychology of Physical Activity: Determinants, Well-being and Interventions*. London: Routledge; 2001.
15. Teixeira PJ, Going SB, Houtkooper LB, Cussler EC, Metcalfe LL, Blew RM, et al. Exercise motivation, eating, and body image variables as predictors of weight control. *Med Sci Sports Exerc* 2006;38(1):179-88.
16. Michie S, Abraham C. Interventions to change health behaviours: evidence-based or evidence-inspired? *Psychology and Health* 2004;19:29-49.
17. Kraemer HC, Wilson GT, Fairburn CG, Agras WS. Mediators and moderators of treatment effects in randomized clinical trials. *Arch Gen Psychiatry* 2002;59(10):877-83.

18. Baranowski T, Klesges LM, Cullen KW, Himes JH. Measurement of outcomes, mediators, and moderators in behavioral obesity prevention research. *Prev Med* 2004;38 Suppl:S1-13.
19. Oakley A, Fullerton D, Holland J, Arnold S, France-Dawson M, Kelley P, et al. Sexual health education interventions for young people: a methodological review. *Bmj* 1995;310(6973):158-62.
20. Wammes B, Kremers S, Breedveld B, Brug J. Correlates of motivation to prevent weight gain: a cross sectional survey. *Int J Behav Nutr Phys Act* 2005;2(1):1.
21. Vidal PM, Dias CM. Trends in overweight and obesity in Portugal: The National Health Surveys 1995-6 and 1998-9. *Obesity Research* 2005;13(7):1141-1145.
22. Wing R, Hill J. Successful Weight Loss Maintenance. *Annual Review Nutrition* 2001;21:323-341.
23. Williams GC, Minicucci DS, Kouides RW, Levesque CS, Chirkov VI, Ryan RM, et al. Self-determination, smoking, diet and health. *Health Educ Res* 2002;17(5):512-21.

O Programa PESO COMUNITÁRIO⁶

⁶ Silva, M.N., Santos, T.C., Coutinho, S.R., Marcelino, M.S., Vieira, P.N., Tomás, R.A., Carraça, E.V., Minderico, C.S., Sardinha, L.B. e Teixeira, P.J. (2009). O Programa PESO COMUNITÁRIO. *Comportamento Alimentar* 6: 1-12.

RESUMO

Baseado num enquadramento científico e técnico apropriado, em orientações internacionais e em princípios de mudança comportamental validados e implementado por uma equipa com competências especializadas adquiridas com a prática de investigação nos determinantes do controlo do peso, o Programa PESO COMUNITÁRIO apresenta-se como um programa de prevenção e tratamento da obesidade, disponível de forma gratuita para toda a população adulta interessada em gerir o seu peso e saúde. O presente artigo visa a descrição pormenorizada deste Programa, apresentando o seu contexto, objectivos, estruturação das sessões e implementação. Procura-se ainda descrever com detalhe os participantes nele envolvidos e suas características, bem como apresentar e discutir resultados preliminares que apontam para a eficácia deste tipo de intervenção comunitária.

ABSTRACT

Aiming at the prevention and treatment of obesity in the community at large, the PESO COMUNITÁRIO Program is based on appropriate clinical guidelines and on validated behavior change principles. Implemented by an intervention team with expertise gained from current scientific research in weight control determinants, this Program is free of charge for all interested adults who wish to manage their weight and health. This article describes the Program in detail, presenting the context, objectives, structure and implementation of the sessions. Another goal is to provide a detailed characterization of the participants and to present and discuss preliminary results, which point to the effectiveness of this type of community intervention.

ENQUADRAMENTO TEÓRICO E CONTEXTUAL DO PROGRAMA

É hoje constatação largamente generalizada que a obesidade constitui uma grave ameaça para a saúde pública pela sua ligação à doença crónica e comprometimento da qualidade de vida, projectando-se que, em 2025, mais de 50% da população mundial possa ter obesidade (Chopra & Darnton-Hill, 2002). Portugal não constitui excepção a esta realidade e de acordo com o mais recente estudo de prevalência (Carmo et al., in press) verifica-se que mais de metade da população Portuguesa adulta apresenta um peso superior ao desejável (53.6%), sendo que cerca de 14,2% apresentavam obesidade (IMC superior a 30 kg/m²). Embora se reconheça o papel de factores genéticos para estes números, uma elevada parcela de responsabilidade está associada a índices inadequados de actividade física aliados a dietas inadequadas, pelo que a elaboração de programas de controlo do peso baseados nestes comportamentos é parte integrante da solução actualmente indicada como referencial (Wadden, Brownell, & Foster, 2002). Segundo as recomendações do National Institute of Health dos EUA (USDHHS, 1998) o tratamento da obesidade ou excesso ponderal deve promover o exercício regular, a restrição calórica e incluir estratégias de modificação comportamental. A este propósito, é importante considerar-se que as intervenções não têm geralmente um efeito directo no comportamento das pessoas mas sim um efeito indirecto, através da sua influência em factores intermédios ou mediadores. Ou seja, o profissional de saúde procura afectar as condicionantes internas (p.ex., motivação, competências) ou externas (p.ex., oportunidades, exposição a factores de risco) que estimulem e/ou permitam ao utente a tomada de decisão autónoma. Atendendo à grande variabilidade inter-individual nos resultados de participantes em programas de tratamento da obesidade, identificar variáveis potencialmente explicativas do sucesso é um objectivo prioritário nesta área de estudos (Teixeira, Going, Sardinha, & Lohman, 2005).

Estes são os pressupostos principais que estiveram na base da concepção do Programa PESO (Promoção do Exercício e Saúde na Obesidade, Faculdade de Motricidade Humana, 2001-

2009), agora mencionado por ser de fundamental interesse para perceber e enquadrar o contexto que deu origem e que contribuiu para as características actuais da sua aplicação comunitária, na forma do Programa PESO COMUNITÁRIO. Este novo programa e a sua forma de estruturação constituem a extensão à comunidade de um corpo sólido de conhecimentos e técnicas essenciais à gestão do peso, decorrentes de um passado de investigação científica através do Programa PESO, que configurou um estudo de investigação experimental prospectivo controlado, com distribuição aleatória por grupos e longitudinal (acompanhando os seus participantes por 3 anos), procurando identificar preditores de sucesso do tratamento da obesidade (o que funciona? como? para quem?), testando um determinado modelo de intervenção não-farmacológica, sólidamente fundamentado teórica e empiricamente e avaliado em condições laboratoriais únicas no nosso país.

No programa PESO, após a fase de intervenção experimental (e estando todas as participantes a serem seguidas em follow-up) tornou-se uma prioridade a extensão dos saberes e práticas adquiridas a toda a comunidade, num programa já livre de constrangimentos experimentais, sem fins de investigação, permitindo o acesso por parte de um número alargado de pessoas a um programa gratuito, de forte cariz educacional no âmbito do combate à obesidade. Foi então concebido o Programa PESO COMUNITÁRIO, a funcionar desde 2005, que visa prevenir a obesidade ou reduzir o peso em excesso, bem como alguns dos riscos da obesidade associados à saúde em adultos, mediante uma mudança saudável e estável dos hábitos, atitudes e comportamentos. O Programa procura oferecer soluções e recursos práticos para todos os que pretendem perder peso, prevenir o ganho de peso ou ajudar terceiros na obtenção e manutenção de um peso saudável.

PESO COMUNITÁRIO: Para Quem?

Apesar de não existir limite superior de idade, este programa foi essencialmente concebido para uma população adulta activa e com idade inferior a 65 anos. Isto porque as recomendações do programa estão de acordo com a mais completa autonomia física e funcional, não estando delineadas para determinadas condições clínicas e limitações musculoesqueléticas (grupos específicos podem ter necessidades específicas às quais o programa pode não corresponder inteiramente). A esta constatação acresce a controvérsia relativa à relevância da perda de peso em pessoas de idades mais avançadas.

A divulgação do programa com vista à admissão de novos participantes é realizada regularmente através de anúncios divulgados nos media (televisão, revistas, jornais, rádio), convites enviados para diversos list-servers, posters, flyers e acções de divulgação em diversos serviços de saúde (p.ex. grande maioria dos Centros de Saúde da Sub-Região de Saúde de Lisboa), e através de um site desenvolvido especificamente para dar apoio ao Programa: www.pesocomunitario.net.

PESO COMUNITÁRIO: Onde, Como e Com que Equipa?

O programa decorre nas instalações da Faculdade de Motricidade Humana e é implementado por uma equipa multidisciplinar de técnicos especialistas em obesidade do Laboratório de Exercício e Saúde (nutricionistas e dietistas, fisiologistas do exercício, médicos e psicólogos), todos eles com formação pós-graduada. Esta equipa e o programa são coordenados cientificamente por professores/investigadores especialistas em obesidade e controlo do peso, sob a responsabilidade do Professor Pedro Teixeira. A opção por uma equipa multidisciplinar reflecte as guidelines mais actuais, defendendo soluções integradas para problemáticas complexas como é o caso da obesidade. O Programa realiza-se em duas aplicações anuais em continuidade e cada aplicação dura em média 4 meses, estruturando-se em 16 sessões de hora

e meia, maioritariamente em horário pós-laboral e durante a semana (com sessões especiais pontuais aos Sábados).

PESO COMUNITÁRIO: Que Objectivos para os Participantes?

O programa pretende promover alterações estáveis dos hábitos e estilos de vida dos participantes. Baseando-se na constatação fundamental de que, no início de qualquer processo de mudança, é essencial definir e partilhar objectivos claros, para que todos os intervenientes conheçam as metas a atingir e também para seja possível monitorizar o progresso ao longo do tempo, são apresentados como objectivos para cada participante:

- Assistir a todas as sessões;
- Aumentar o conhecimento sobre tópicos essenciais para o controlo do peso;
- Reduzir ou manter o peso e gordura corporais;
- Aumentar a actividade física (atingir 30-45 minutos na maioria dos dias da semana);
- Melhorar a qualidade nutricional e alimentar;
- Reduzir 300-500 quilo-calorias diárias (para o caso da perda de peso...);
- Assumir o controlo pelas suas escolhas e comportamentos;
- Desenvolver competências de monitorização do seu controlo do peso (peso, actividade física, alimentação).

Estes objectivos prendem-se com alterações simples e passíveis de serem integradas no quotidiano, sendo enquadrados na filosofia de base do programa, a de envolver a pessoa no seu processo, abandonando a procura de controlo externo, desenvolvendo uma atitude e motivação mais autónomas acerca da gestão do seu peso e respectivas influências, e responsabilizando-se pelas suas escolhas e comportamentos.

PESO COMUNITÁRIO: Que Conteúdos de Intervenção?

De forma a se alcançarem os objectivos propostos para o programa, a estruturação dos conteúdos das sessões passa por temas referentes às áreas da Obesidade e do Controlo do Peso, Nutrição e Alimentação, Actividade Física, Psicologia e Modificação Comportamental, divulgados num clima de promoção e suporte da competência pessoal e da autonomia. Na tabela seguinte é possível verificar a estruturação dos conteúdos temáticos, sessão a sessão, por área de intervenção, seguindo-se uma explicação sucinta dos principais objectivos de cada área:

Nº Sessão ⁷	Títulos e Tópicos das Sessões
Área Temática: a “Ciência” do Controlo do Peso e da Saúde	
1	GERIR O PESO E A SAÚDE: UM PUZZLE COM MUITAS PEÇAS... Apresentação do Programa PESO COMUNITÁRIO Como se Ganha e Perde Peso: Exercício vs. Alimentação O Índice de Massa Corporal e as Suas Limitações A Promoção do Exercício e Saúde na Obesidade
11	COMO MONITORIZAR A SAÚDE O Participante como Agente da sua Saúde A Obesidade e as Principais Doenças Crónicas A Importância dos Indicadores de Saúde Factores de Risco na Saúde Física, Comportamental e Emocional
Área Temática: Nutrição e Alimentação	
2	UMA ALIMENTAÇÃO SAUDÁVEL PARA UM PESO SAUDÁVEL Educação Nutricional e Alimentar para o Controlo do Peso Os Nutrientes Calóricos e Não-Calóricos: A Densidade Energética Como Reduzir a Gordura Alimentar e as Calorias O Planeamento e o Fraccionamento Alimentares
5	RÓTULOS E ESCOLHAS ALIMENTARES Como Ler um Rótulo Saber Comprar no Supermercado Escolher Refeições Fora de Casa Como e Quando Contar as Calorias dos Alimentos
9 <i>(Sessão especial:Sábado)</i>	NAS ENCRUZILHADAS DA NUTRIÇÃO O Que é Actualmente Uma Alimentação Saudável A Relação entre os Alimentos e a Saúde e Bem-Estar Padrões e Opções Alimentares a Promover e Evitar num Dia Típico Controvérsias e Novidades no Nosso Prato
12	MAIS SOBRE ALIMENTAÇÃO PARA O CONTROLO DO PESO Estratégias Práticas de Moderação da Ingestão Calórica A Sopa: Fonte de Saúde e Oportunidades Nutricionais Prevenção para Ocasões Especiais

⁷ Apesar de o programa contar com 16 sessões apenas se encontram listadas 14, uma vez que 2 sessões ficam normalmente a cargo de convidados especiais, que podem variar de aplicação para aplicação.

Nº Sessão	Títulos e Tópicos das Sessões
Área Temática: Actividade Física	
3	ACTIVIDADE FÍSICA: PORQUÊ COMEÇAR Os Inúmeros Benefícios da Actividade Física Regular Aumentar o Dispendio Energético com Desporto, Exercício e Actividade Física As Muitas Formas de um Estilo de Vida Activo Marcha: A “Rainha” das Actividades Físicas
6	COMO IMPLEMENTAR O SEU PROGRAMA DE ACTIVIDADE FÍSICA O Que Esperar de um Ginásio Como Planear e Monitorizar a Sua Prática de Exercício Físico Quantas Calorias Gastar e Como o Fazer Recomendações de Actividade Física para o Controlo do Peso
7 <i>(Sessão especial: Sábado)</i>	SESSÃO ESPECIAL - PESO COMUNITÁRIO EM ACÇÃO Actividade Fora de Portas: Sessão Prática de Actividade Física
13	DECIDIR MELHOR: COMO VENCER A PREGUIÇA Razões para Ser Fisicamente Activo Como Encontrar e Manter a Sua Motivação Testemunhos de Pessoas Activas
Área Temática: Psicologia e Modificação Comportamental	
4	ALIMENTAÇÃO EMOCIONAL A Importância das Emoções no Comportamento Alimentar O Que é a Fome Emocional: Os Vários Tipos de “Fome” Como Identificar e Prevenir a Fome Emocional Estratégias Práticas para Minimizar o Impacto da Alimentação Emocional
8	GESTÃO DO STRESSE E RESOLUÇÃO DE PROBLEMAS Stresse: Mecanismo Adaptativo e Implicações na Obesidade Técnicas de Gestão do Tempo no Dia-a-Dia Resolução de Problemas: O Método dos Cinco Passos Como Implementar Eficazmente um Estilo de Vida Saudável e Activo
10	PRESSÃO SOCIAL E IMAGEM CORPORAL: A QUE PESO Expectativas Pessoais: Impacto na Gestão do Peso Imagem Corporal e Excesso de Peso: Uma Constelação de Risco Pressão Social e Discriminação na Obesidade Estratégias Práticas de Gestão e Promoção da Imagem Corporal
16	O PARTICIPANTE COMO ESPECIALISTA DO CONTROLO DO PESO Perda ou Manutenção do Peso: Diferenças e Semelhanças Estratégias Essenciais para a Gestão do Peso a Longo Prazo Análise Crítica das Opções Disponíveis para Perder Peso Encerramento do Programa PESO COMUNITÁRIO

Sendo este um programa de cariz comunitário e educacional, procura-se através destes conteúdos contribuir principalmente para a promoção e implementação da “saúde positiva”, de acordo com a definição da Organização Mundial de Saúde e partilhando a perspectiva de Cristoph Djours de que “A saúde é a capacidade de cada homem, mulher ou criança, para criar e lutar pelo seu projecto de vida, pessoal ou original em direcção ao bem-estar”. Neste sentido, a saúde, na qual se enquadra uma gestão equilibrada do peso corporal, não é objectivo último, mas antes um meio para que cada participante possa atingir os seus objectivos.

Na área da nutrição, no sentido de se atingir uma melhoria da quantidade/qualidade e das calorias ingeridas, várias sessões procuram aumentar a informação e conhecimentos dos participantes, desmistificando ideias erradas e conduzindo a escolhas mais informadas e sustentadas. São abordadas questões ligadas à composição nutricional e energética dos alimentos, redução da gordura e energia na alimentação, aumento dos factores de saciedade na dieta, redução do índice glicémico, importância do planeamento e fraccionamento alimentar, redução do tamanho das porções habituais, planeamento das escolhas em ocasiões especiais (férias, festas), dicas para comer fora de casa, sugestões de culinária e preparação dos alimentos, aprendizagem de leitura de rótulos, entre outros. Nesta área sublinha-se a ideia central da gestão calórica do dia alimentar. Ao invés de se apostar na prescrição de planos alimentares, procura-se aumentar a capacidade de cada participante para fazer a sua própria gestão calórica e nutrição, de acordo com os seus condicionalismos, recursos e gostos pessoais.

No que concerne à actividade física, o carácter predominantemente tutorial das sessões visa o aprofundamento da compreensão de aspectos fundamentais para o sentimento de autonomia e de competência face à acção: saber escolher actividades e contextos de prática, porque escolher e como o colocar em prática eficazmente. Para além das questões do equilíbrio energético, são abordados tópicos como desenvolver e implementar um plano de exercício/actividade física formal no sentido de aumentar o dispêndio calórico; como promover o aumento da actividade física diária (informal) de forma integrada no estilo de vida; benefícios e riscos da actividade física; uso correcto dos equipamentos, vestuário e outras questões de segurança; como auto-monitorizar a intensidade do exercício (p.ex., frequência cardíaca, escala subjectiva de esforço); uso de pedómetros, sua calibração e interpretação, entre muitos outros. De forma complementar, são promovidas não só caminhadas regulares aos Sábados (procurando-se a descoberta de diferentes percursos

pedestres que possam estimular o gosto por esta actividade e a sua consequente adopção em autonomia), como é também oferecida uma sessão especial com vários tipos de actividades, permitindo aos participantes experimentarem e poderem perceber que tipo de actividades lhes agradam mais. O principal objectivo destas iniciativas é aumentar nos participantes o conhecimento de opções disponíveis para a prática, aumentar a sua competência para o exercício, motivar os participantes para procurarem implementar, no contexto das suas vidas, a sua própria rotina de actividade física. Seguindo a estratégia definida, o foco é sempre colocado na iniciativa, interesse e autonomia do participante. De facto, para ser possível atingir consistência comportamental no longo prazo, é fundamental promover o desenvolvimento de motivos mais auto-determinados, sendo central que os participantes se envolvam em actividades que sejam intrinsecamente motivadoras, agradáveis, valorizadas pessoalmente (bem integradas) e não externamente controladas. Em mulheres obesas, verificou-se recentemente que o aumento da motivação intrínseca para o exercício foi o preditor psicossocial mais forte da perda de peso a longo prazo (Teixeira et al., 2006). A alteração inicial da motivação intrínseca para o exercício, nomeadamente o aumento das sensações de prazer, auto-eficácia e competência na actividade física surgiram como preditores significativos da perda de peso no longo prazo.

Ao longo do programa são esperadas dificuldades específicas relacionadas com o processo de mudança ao nível da adopção de estilos de vida mais saudáveis. Embora não proporcione um acompanhamento individualizado, o programa procura estimular a busca do auto-conhecimento, nomeadamente explorar o que poderá estar na base de determinados padrões alimentares e de actividade física. Para tal, diversas estratégias são estimuladas, a maioria baseada na auto-monitorização (alimentação, actividade física, peso) enquanto ferramenta a utilizar e integrar, permitindo tornar consciente e identificável o automático, sendo possível identificar padrões de comportamento e respectivos níveis de desempenho. Questões

relacionadas com o equilíbrio emocional e com a gestão dos pensamentos, emoções e comportamentos têm também que ser consideradas. A vivência de determinadas questões psicossociais ligadas à pressão social para emagrecer e à cultura alimentar (e função que os alimentos podem assumir), bem como a gestão que é feita do tempo e do stresse, podem constituir barreiras à eficaz gestão do peso (constituindo não só elementos de base como de manutenção do problema). Neste sentido, o trabalho a desenvolver prende-se com a identificação das distorções, muitas vezes promovidas pela pressão social, pretendendo-se contribuir para a auto-aceitação, auto-conhecimento e investimento pessoal a qualquer peso, tendo em conta a individualidade de cada participante, os seus objectivos e interesses.

Dada a crescente evidência científica de que a maioria do peso perdido em programas de perda de peso é recuperada no médio/longo prazo (Wing & Hill, 2001), a última componente do programa incide no desenvolvimento de estratégias para otimizar a fase de manutenção, tais como: definição do padrão de peso a ser mantido; estabelecimento de um sistema de monitorização do peso prático e passível de ser mantido; promoção do conhecimento, interpretação de alterações corporais e desenvolvimento de planos de contingência, ou seja, saber quando e como agir de forma rápida.

RECURSOS COMPLEMENTARES ÀS SESSÕES

Sendo este um programa de índole comunitária, com sessões maioritariamente tutoriais, onde o espaço para a interacção é limitado, procurou-se tirar partido de variados recursos on-line que servissem de apoio, aprofundamento complementar às sessões e também de dinamização da interacção entre os participantes. O website www.pesocomunitario.net é o principal local para acompanhamento permanente do programa, no que diz respeito a notícias, conteúdos de interesse, testemunhos e outras informações. Nele podem encontrar-se:

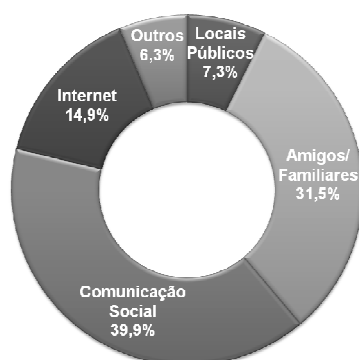
- **Newsletter electrónica semanal:** procurando uma maior proximidade entre o programa e o participante, a Newsletter promove uma mensagem semanal da equipa, um pequeno balanço da última sessão e uma chamada para os tópicos mais importantes a abordar na sessão seguinte, bem como dicas e acontecimentos a decorrer na comunidade, desafiando os participantes a envolverem-se em actividades na comunidade e entre si.
- **A Agenda das Sessões:** permite que qualquer pessoa possa estar informada sobre a sessão a realizar-se nessa semana e respectivo calendário de todas as sessões.
- **Documento-Resumo de Cada Sessão:** o documento-resumo de cada sessão inclui os tópicos abordados na mesma, bem como recursos (links, livros, etc) seleccionados pela equipa, pertinentes para o tema em causa.
- **Recursos da Sessão:** o item Recursos (de acesso reservado) destina-se exclusivamente aos participantes do programa, sendo que para entrar nesta área privada é necessária uma password. Na área de acesso reservado são disponibilizados os slides mais relevantes da sessão, comentados pelo prelector, bem como um conjunto de recursos relevantes para o tema em questão (grelhas de auto-monitorização, documentos de apoio, tabelas de interesse, etc.)
- **Blogue:** o Blogue constitui-se como um espaço virtual público para partilha de pensamentos, ideias e experiências sobre o programa e o controlo do peso em geral. O participante pode responder directamente aos posts (mensagens) colocados pela Equipa através de comentários, sugestões e críticas, ou sugerir novos posts.
- **Área Teste os Seus Conhecimentos:** neste inquérito pode fazer-se semanalmente uma auto-avaliação dos conteúdos referentes a cada sessão e partilhar com familiares/amigos. As respostas são confidenciais e o participante acede à correcção das respostas dadas, permitindo aumentar o seu conhecimento.

CARACTERIZAÇÃO DOS PARTICIPANTES

Entre 2005 e 2008 registaram-se mais de 2000 pré-inscrições on-line, indicando que um número alargado de pessoas teve conhecimento do programa. Posteriormente, 677 participantes iniciaram o programa PESO COMUNITÁRIO.

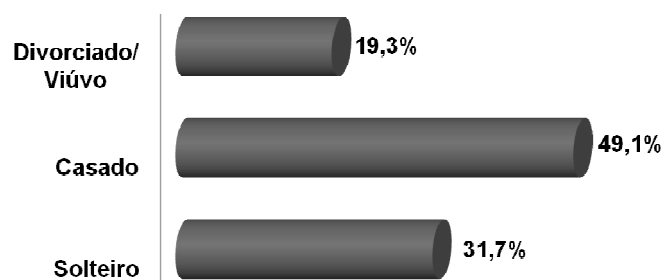
Cerca de 70% dos participantes tiveram conhecimento do programa, através dos meios de comunicação social ou por via de amigos/familiares.

Figura 1. Meios através dos quais os participantes tiveram conhecimento do programa



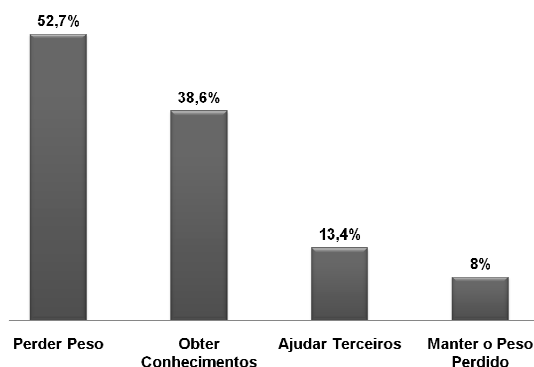
A população é composta por 84,2% de participantes do género feminino e 15,8% do género masculino, sendo que a média de idades se encontra nos 44,6 anos, variando entre os 20 e os 72 anos (respectivamente, valores mínimo e máximo).

Figura 2. Distribuição de participantes quanto ao estado civil



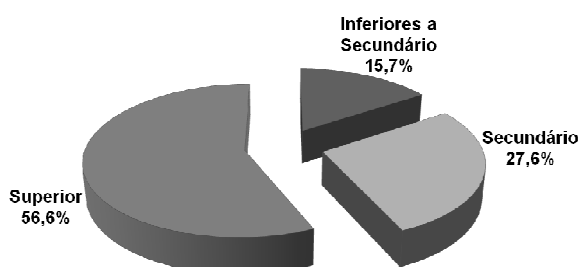
No momento em que iniciaram o programa as expectativas mais prevalentes dos participantes eram essencialmente de perda de peso e de obtenção de conhecimentos (nota: no questionário representado na figura 3, os participantes podiam escolher mais que uma opção).

Figura 3. Expectativas no momento de entrada no Programa



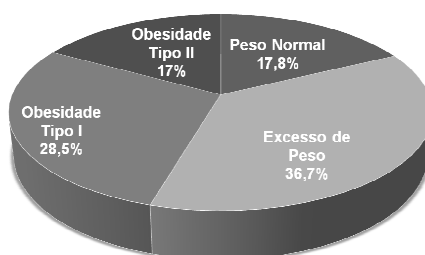
Em termos de nível educacional, a maioria dos participantes apresentam habilitações literárias de nível superior.

Figura 4. Distribuição de participantes quanto ao nível educacional



A população divide-se quanto aos valores de índice de massa corporal em 54,5% de participantes sem obesidade e 45,5% de participantes com obesidade.

Figura 5. Distribuição de participantes quanto ao índice de massa corporal (IMC)



No momento inicial do programa, os dados referentes à prevalência de história clínica indicam que as condições médicas mais comuns nesta população são palpitações, hipertensão, dores na coluna, problemas ósseos e articulares e dores corporais generalizadas. Cerca de 12,4% dos participantes refere também a existência de distúrbios de funcionamento da tiróide. A existência de limitações físicas auto-reportadas para a prática da actividade física verifica-se em 27% dos participantes, ainda que a maioria refira não ter limitações físicas.

As razões percebidas para a dificuldade na gestão do peso apresentam-se de seguida:

Maior contributo para o aumento do peso:

- Alimentar-se em actos sociais ou festas;
- O bom sabor da comida;
- Alimentar-se demasiado ao jantar;
- Desejo por certos alimentos;
- Sensação de stresse, depressão ou solidão.

Menor contributo para o aumento do peso:

- Alimentar-se quando se está feliz;
- Alimentar-se enquanto se cozinha;
- Alimentar-se quando se está cansado;
- Alimentar-se em excesso ao almoço ou ao pequeno-almoço.

No que diz respeito à **actividade física** a maioria dos participantes (63,3%) revelava um nível de moderado a elevado no seu gosto pela actividade física, no momento inicial do programa. No que diz respeito às actividades físicas preferidas destacaram-se actividades individuais, salientando-se a caminhada ao ar livre, seguida da bicicleta estacionária, natação e caminhar em passadeira rolante. Outras actividades listadas como menos cativantes foram o futebol, o voleibol, o basquetebol e o golfe. A caracterização das actividades preferidas e do gosto pelo exercício antes do início de cada intervenção pode ser um importante elemento dinamizador da prática futura. De facto, o gosto pela marcha veio a traduzir-se nos elevados níveis de adesão a este tipo de actividade ao longo da intervenção.

Ao nível da **alimentação**, no momento inicial do programa, um número elevado de participantes (49,5%) referiu sentir descontrolo na sua alimentação 1 ou menos vezes por semana, enquanto que 21,3% indicou que a sua alimentação se descontrolava 4 ou mais vezes por semana.

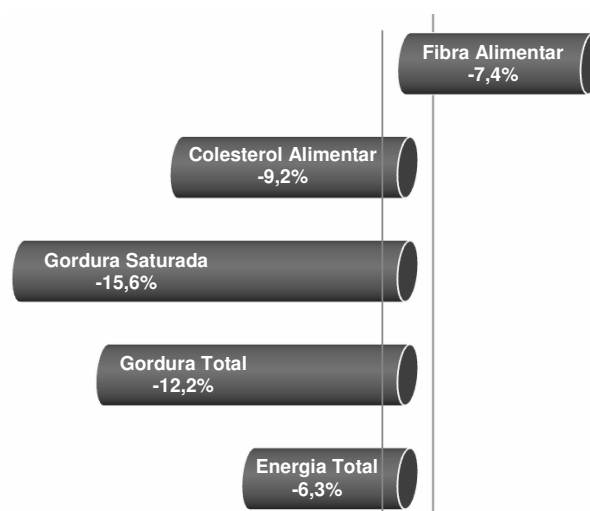
RESULTADOS

Apesar de não se assumir como um programa de investigação científica, são realizadas avaliações iniciais e finais numa lógica de avaliação do impacto do programa e de monitorização do mesmo. Sendo um programa a decorrer em continuidade, a análise dos resultados é também um processo em constante actualização. Não obstante, e no que diz respeito às cinco primeiras aplicações do programa, apresentam-se em seguida indicadores que permitem aferir o impacto do Programa.

Em termos de alterações verificadas na actividade física, comparando o momento inicial e final do programa, verifica-se que os minutos de actividade física moderada aumentaram 116%, para o valor de 260 min/semana, e o dispêndio energético em caminhada aumentou 97%, para o valor de 1234 kcal/semana.

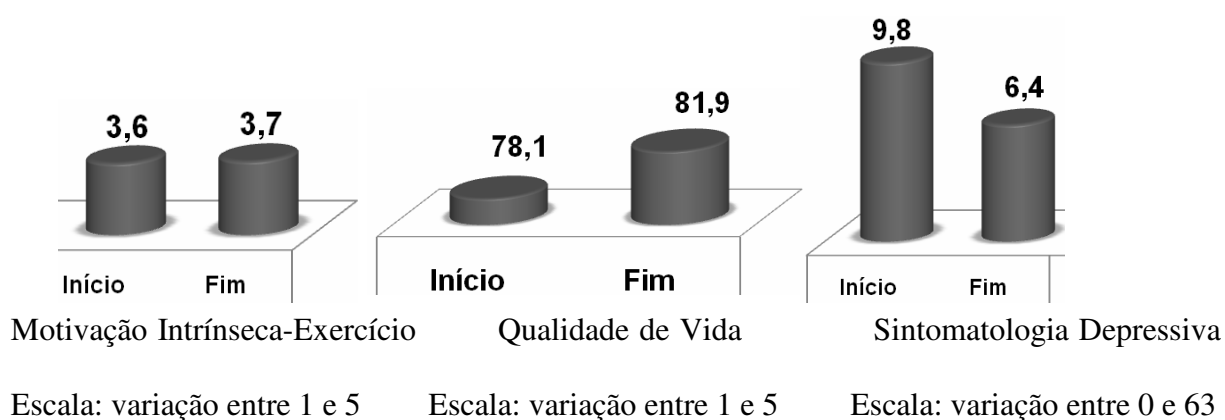
No que diz respeito a alterações nutricionais comparando o momento inicial e final do programa, verifica-se que a ingestão energética total foi reduzida para 2331 kcal/dia, existindo também uma redução do colesterol alimentar (para 294 mg/dia), do consumo da gordura total (para 82,6 g/d) e da gordura saturada (para 23,8 g/d). Constatou-se ainda que existiu um aumento no consumo de fibra alimentar, para valores de 36,4 g./dia.

Figura 6. Alterações percentuais em variáveis nutricionais, comparando o momento inicial e final



Foram também verificadas alterações em algumas variáveis psicossociais, nomeadamente uma diminuição da sintomatologia depressiva quando comparamos o momento inicial e final do programa. Por sua vez a motivação intrínseca para o exercício aumentou, salientando-se das 4 sub-escalas que compõem esta variável (prazer/satisfação, percepção de competência, esforço/importância, tensão/pressão) a sub-escala de percepção de competência. A qualidade de vida dos participantes revelou também uma melhoria, destacando-se dentro desta variável a sub-escala da auto-estima relativamente às restantes sub-escalas.

Figura 7. Alterações em variáveis psicossociais, comparando o momento inicial e final do Programa



PESO COMUNITÁRIO: A Palavra aos Participantes

A necessidade de uma avaliação mais próxima e real da forma como o programa é vivido e processado pelos participantes traduziu-se na utilização complementar de metodologias qualitativas de avaliação. No final de cada aplicação do programa todos os participantes puderam realizar o seu balanço individual acerca da participação no programa e mudanças por ele induzidas. Estes testemunhos foram então sujeitos a análise de conteúdo, tendo sido

criadas categorias de resposta (apresentadas por frequência), expressando as principais vivências referenciadas como resultado da participação no Programa.

Qualidade do Programa (89%): Testemunhos de elogio à qualidade dos oradores, clareza e interesse das exposições, bem como à estruturação do curso: temas abordados e lógica de acção (dar ferramentas ao invés de prescrever).

Alteração de Hábitos/Passagem à Prática (68%): Testemunhos de adaptação na vida do dia a dia das informações/sugestões/estratégias defendidas pelo programa, fazendo referência a alterações na forma de alimentação (quantidade, fraccionamento, qualidade) e na adopção de um estilo de vida mais activo (adopção de caminhadas e frequência de ginásios). A maioria dos participantes que mencionou esta categoria referiu alterações nos dois níveis.

Conhecimentos Adquiridos (55%): Referências à aprendizagem a diversos níveis, seja por obtenção de conteúdos desconhecidos, seja por “reciclagem”de informação, seja por “destruição de mitos” e formas erradas de conhecimento prévio.

Ganhos Pessoais Independentes da Perda de Peso (42%): Testemunhos de maior investimento pessoal, maior auto-aceitação, mais bem-estar interior e equilíbrio (mesmo sem perda de peso), sendo também referidos ganhos em termos de qualidade de vida e saúde.

Auto-Conhecimento/Maior Consciência de Si (22%): Referências ao programa como tendo promovido uma maior noção de padrões de acção e formas de pensar, que levaram a maior descoberta e conhecimento pessoal.

Barreiras Pessoais (20%): Testemunhos referentes a impedimentos pessoais pontuais para não estar presente nas sessões e/ou envolver-se com o mesmo (divórcio, situações profissionais difíceis, desemprego...).

Generalização de Conhecimentos (10%): Referências à alteração de hábitos de outras pessoas (familiares) por transmissão de conhecimentos adquiridos no programa e partilha de experiências.

CONCLUSÃO

Os resultados das primeiras aplicações deste programa configuram uma base de confiança para a sua continuação. O sucesso da sua aplicação traduz-se em parte pelo elevado número de pessoas já abrangidas pelo mesmo, quer como participantes, quer por extensão de saberes a familiares e até utentes (uma vez que uma parte destes participantes são técnicos de saúde movidos pelo desejo de aumentar a sua formação nesta área). Tal vem de encontro ao objectivo de extensão comunitária de um corpo de saberes cientificamente validados, permitindo também uma maior integração da Faculdade de Motricidade Humana na sua comunidade envolvente.

São também de realçar as alterações alcançadas no decurso deste programa, reportadas não só em termos quantitativos como qualitativos. Comportamentos mais compatíveis com a promoção de estilos de vida saudáveis (fundamentais para o controlo do peso) encontram-se expressos no aumento dos níveis de actividade física (p.ex., aumento em 16% da actividade física moderada semanal), e na alteração do padrão nutricional, de onde se salientam a redução da ingestão energética total, a redução do colesterol alimentar, a redução da gordura saturada e o aumento da fibra alimentar. Também a nível psicossocial o quadro encontrando-se afigura positivo, com aumentos significativos na motivação intrínseca para o exercício e em dimensões chave da qualidade de vida, bem como reduções na sintomatologia depressiva, entre outros.

Todos os resultados apresentados representam um feed-back directo do trabalho realizado, mas são também fonte de reflexão com vista à sua continuação futura. O objectivo comunitário de promover estilos de vida mais activos e saudáveis, conducentes a uma eficaz gestão do peso no longo prazo e atingindo uma fatia cada vez mais larga da população (e não apenas aquela disposta a deslocar-se às instalações da Faculdade), leva à consideração de

novos caminhos e formas de aplicação, que se pretendem cada vez mais eficazes e aplicáveis a diferentes contextos e necessidades. A abordagem comunitária de livre inscrição e acesso aos cursos ministrados nas instalações da Faculdade pode, esgotadas as necessidades desta área geográfica, mudar de lógica e passarem a ser os próprios técnicos a deslocarem-se a contextos públicos ou privados (Centros de Saúde, empresas, autarquias, etc.) desde que justificada a sua pertinência e especificidade. Dado o facto deste ser um programa de curta duração (4 meses) mas totalmente estruturado para preparar a manutenção futura dos comportamentos, um próximo desafio será o de apostar em novos esquemas de avaliação desse longo prazo (por telefone ou e-mail). Testados os conteúdos do programa em termos de importância, utilidade e auxílio na mudança comportamental, bem como as diferentes estratégias de comunicação a utilizar, será alcançada uma base de conhecimento que se pretende constituir como um modelo a seguir.

AGRADECIMENTOS

Os responsáveis pelo Programa PESO COMUNITÁRIO reconhecem e agradecem o apoio essencial de várias instituições, que garantem as condições necessárias para que um programa desta dimensão possa funcionar sem custos para os seus utentes: Câmara Municipal de Oeiras, Danone e Nacional e Jornal Público.

O PESO COMUNITÁRIO conta também com o apoio institucional da Direcção Geral de Saúde – Plataforma Contra a Obesidade e da Sociedade Portuguesa para o Estudo da Obesidade.

Reconhece-se ainda o contributo das seguintes pessoas que, de formas distintas, contribuíram para o sucesso deste Programa: Ricardo Martins (falecido), Alexandra Rodrigues (falecida), Isabel do Carmo, José Luís Themudo Barata, Sandra Martins, Cláudia Viegas, Madalena Muñoz, Margarida Castro, Ana Quitério, Catarina Matias, Elvis Carnero, Filipa Limão, Maria

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REFERÊNCIAS BIBLIOGRÁFICAS

Carmo, I., Santos, O., Camolas, J., Vieira, J., Carreira, M., Medina, L., et al. (in press). Prevalence of obesity in Portugal: preliminary results of a face-to-face survey. *Obesity Reviews*.

Chopra, M., & Darnton-Hill, I. (2002). A global response to a global problem: the epidemic of overnutrition. *Bulletin World Health Organization*, 80(12), 952-958.

Teixeira, P. J., Going, S. B., Sardinha, L. B., & Lohman, T. G. (2005). A review of psychosocial pre-treatment predictors of weight control. *Obesity Review*, 6(1), 43-65.

Teixeira, P. J., Going, S. B., Houtkooper, L. B., Cussler, E. C., Metcalfe, L. L., Blew, R. M., et al. (2006). Exercise motivation, eating, and body image variables as predictors of weight control. *Medicine and Science in Sports Exercise*, 38(1), 179-188.

USDHHS. (1998). *Clinical Guidelines on the identification, evaluation, and treatment of overweight and obesity in adults*: NIH-National Heart, Lung, and Blood Institute Bethesda, MD.

Wadden, T. A., Brownell, K. D., & Foster, G. D. (2002). Obesity: responding to the global epidemic. *Journal of Consulting Clinical Psychology*, 70(3), 510-525.

Wing, R., & Hill, J. (2001). Successful Weight Loss Maintenance. *Annual Review of Nutrition*, 21, 323-341.

Abstracts of presentations (oral and poster) related to the Thesis

Published Abstracts

Silva, MN, Vieira PN, Coutinho SR, Carraça EV, Santos, T, Markland D, Sardinha LB, Teixeira PJ. Autonomous motivation for exercise, exercise levels, and 3-year weight change: Results from a randomized controlled intervention. International Journal of Obesity (in press)

Introduction: Weight loss programs have largely ignored motivational factors for sustained behavioral change, a fact which may partially account for the current low success rates. This study was part of a longitudinal RCT, consisting of a 1-year theory-based behavior change intervention and a 2-year follow-up period with no intervention, designed to identify predictors of long-term success.

Methods: 221 women participated (37.6 ± 7 y; 31.6 ± 4.1 kg/m² BMI). The main intervention was designed to increase physical activity and internal motivation, following self-determination theory. The model incorporates randomization condition, perceived contextual support and autonomous motivation at 12 months, moderate/vigorous physical activity at 24 months, and 36-month weight change. Paths were tested using partial least squares (PLS) analysis.

Results: At 12 months, group differences for the main motivational intervention targets were medium to large (d : 45-1.35, p s<0.001) favouring the intervention group. At 24 months, the intervention group showed higher activity levels (272 ± 223 min/week vs. 179 ± 174 min/week in controls, $p=0.009$) and higher scores in autonomous regulation for exercise ($d=0.44$, $p<0.001$). At 36 months, % weight change remained higher in the intervention group ($-3.9 \pm 7.6\%$ vs. $-1.3 \pm 7.3\%$ for controls, $p=0.015$). The PLS model tested explained between 19% and 92% of the variance in the target variables, and all hypothesised paths were significant ($p<.001$).

Conclusion: The intervention was successful in affecting theory-driven exercise motivation mediators and long-term physical activity adherence. Furthermore, these variables rested within the causal path of long-term weight loss, providing evidence from a link between experimentally-increased autonomous motivation and physical activity, and 3-year weight management.

Silva M.N.; Markland, D; Vieira P.N., Coutinho S.R., Palmeira A.L., Carraça E.V., Sardinha L.B., Teixeira P.J. Mediators of Different Types of Physical Activity During Behavioral Obesity Treatment. Obesity (in press)

Background: Theory-based experimental research on mediators of behavior change can identify causal mechanisms through which interventions operate. This study aimed at (i) testing causal processes by which a 1-year obesity treatment program based on Self-Determination Theory (SDT) promoted physical activity (PA) and (ii) analyzing whether motivational mechanisms differed substantially in predicting formal and informal PA.

Methods: 239 women (37.6 ± 7.1 y; 31.5 ± 4.1 kg/m²) were randomly assigned to intervention/control groups. The intervention was designed to increase PA and PA motivation,

following SDT. Partial least squares (PLS) latent variable modelling was used to test a causal model comprising experimentally manipulated contextual need support (treatment climate), perceived need satisfaction (autonomy and competence), exercise/PA motivational regulations (autonomous/controlled) and two PA outcomes: moderate-vigorous PA (MVPA, min/wk, 7-d PAR) and a lifestyle PA index (e.g. taking the stairs, walking for transportation, etc.). Where there were intervening variables, tests of mediation were conducted and effect ratios calculated.

Results: Reliability and validity of the measurement model were acceptable (CR between .74 and .98; AVE between .51 and .73) and the structural model explained 6-62% of variance in the dependent variables. Formal MVPA was significantly predicted only by intrinsic motivation ($p < 0.05$). Lifestyle PA was not significantly predicted by any of the motivational regulations. Autonomous regulations were influenced by perceived locus of causality ($p < 0.001$) and by perceived competence ($p < 0.001$), and these needs were in turn influenced by the perceived intervention climate ($p < 0.001$). The effects of treatment on MVPA were mediated by locus of causality for exercise, perceived competence, and exercise intrinsic regulation (effect ratios: .41, .47, .29, respectively).

Conclusions: Specific relationships among variables in the structural model are consistent with SDT and provide support of this framework to enhance our understanding of motivational processes related to exercise/ PA in weight management. Furthermore, results indicate that formal and informal types of PA may be promoted by different processes. While the intervention had a significant direct effect on lifestyle PA – less intrinsically motivating and possibly regulated primarily by habit –, it showed indirect effects on moderate and vigorous PA via specific motivational mechanisms, namely intrinsic regulation.

Silva, M.N., Vieira, P.N., Coutinho, S.R., Palmeira, A.L., Carraça. E.V., Mata, J., Sardinha, L.B., Teixeira, P.J. (2009). Self-Determination and Exercise Intrinsic Motivation as Mediators of Physical Activity During a Weight Loss Program: One-Year Results from a Randomized Controlled Trial. Obesity Facts 2 (Supp 2): 29.

Introduction: Few studies have focused on experimentally influencing motivation-related mediators of physical activity/exercise (PA) in the overweight/obese. Our aim was to evaluate changes in PA and psychological mechanisms of PA behavior change during a one year obesity treatment intervention based on Self-Determination Theory (SDT).

Methods: 239 women (37.6 ± 7.1 y; 31.5 ± 4.1 kg/m²) were assigned to intervention/control groups. The intervention was designed to increase PA and PA motivation, following SDT principles. Assessments included intrinsic motivation-IM; locus of causality-LC, autonomous self-regulation-ASR, psychological motives-PM; and PA: steps/day, moderate+vigorous PA (7-day PAR), and lifestyle activity. Mediation and indirect effects were tested following Preacher and Hayes procedures (2007).

Results: The intervention significantly changed all SDT mediators ($ES = 0.60-1.08$) and increased PA (+147 min/wk moderate+vigorous PA; +1986 steps/day, $ES = 0.89$ for a lifestyle activity index, $p < 0.001$ vs controls). At 12 months (86% retention) associations between PA and SDT mediators ranged between $r = .36$ and $.50$ ($p < 0.001$) and IM, ASR, LCE and PM distinguished ($p < 0.001$) successful (> 150 min/wk PA criteria) from non-successful

participants. In the mediated models, direct effects of intervention on moderate-vigorous and lifestyle PA were reduced but remained significant. Significant ($p < 0.05$) indirect effects were observed through all 4 SDT variables (IM, LC, ASR, PM), suggesting partial mediation. For steps/day, total mediation for PM (i.e., enjoyment, challenge, energy) was observed ($p = 0.003$).

Conclusion: The intervention was successful in affecting theory-driven exercise motivation mediators, which in turn partially explained clinically-significant changes in PA adoption after 1 year. Results are consistent with autonomous self-regulation and intrinsic motivation resting within the causal path of exercise adherence during weight control.

Silva, M.N., Vieira, P.N., Minderico, C.S., Castro, M.M., and Teixeira, P.J. (2008). Autonomy, Self-Regulation, and Intrinsic Motivation Predict Success in a Behavioral Obesity Treatment Program for Women. *International Journal of Obesity* 32 (sup. 1): S144

Purpose: The goal of this study was to analyze 12-month changes in exercise-related psychosocial mediators and their impact on weight loss, in an RCT to test Self-Determination Theory (SDT) for weight management.

Methods: 271 women (age, 37.5 ± 7.1 y; BMI, 27.3 ± 4.1 kg/m²) were assigned to intervention/control groups. The intervention group attended 30 weekly sessions designed to follow SDT. Autonomy-supportive treatment climate and internal causality orientations were predicted to enhance autonomous regulation, perceived competence, and intrinsic motivation for the targeted behaviors, resulting in lasting behavioral and body weight changes. Assessments included body weight, treatment climate (autonomy-supportive vs. controlling), and several SDT variables, some adapted to the exercise domain (exercise motivation, locus of causality, behavioral self-regulation).

Results: Compared to controls, the intervention group ($n = 122$) revealed more weight loss ($p < 0.001$), more self-determination (choice and self-awareness) ($p = 0.006$), and higher exercise autonomous self-regulation (identification, integration) and intrinsic motivation (enjoyment, perceived competence, effort), a more internal locus of causality, and also increased perceived autonomous treatment climate ($p < 0.001$). All psychosocial variables were associated with 12-month weight change ($p < 0.01$). Exercise intrinsic motivation, more autonomous forms of self-regulation for exercise, more internal locus of causality ($p < 0.001$), more self-determination ($p = 0.007$), and autonomous perceived climate ($p = 0.001$) distinguished successful ($> 5\%$ weight loss) from non-successful participants ($< 2\%$ weight loss).

Conclusions: This SDT-based intervention consistently and significantly increased internal regulation and intrinsic motivation, namely for exercise behaviors, and this resulted in positive weight outcomes. Results highlight the important role that autonomous self-regulation may play in weight management, at least in women.

Silva, M.N., Vieira, P.N., Minderico, C.S., Castro, M.M., and Teixeira, P.J. (2007). Using self-determination theory and motivational interviewing for obesity treatment: 1-year results from a randomized controlled trial. *International Journal of Obesity* 31(suppl.): S144.

Goal: The goal of this study was to analyze 1-year change in body weight and exercise-related mediators in a randomized controlled trial (RCT) designed to test Self-Determination Theory (SDT) and Motivational Interviewing (MI) for long-term weight management.

Methods: 169 women (age, 37.2±7.5 y; BMI, 31.8±4.1 kg/m²) were assigned to intervention/control groups. The intervention group attended 30 weekly sessions designed to follow SDT, with an emphasis on promoting intrinsic, self-regulated motivation for exercise and weight control. Key techniques from MI were used throughout the program. Assessments included treatment climate (autonomy- vs. control-supportive) and several SDT variables adapted to the exercise domain (exercise motivation, causality orientations, behavioral self-regulation).

Results: At 1 year, compared to controls, women in the intervention group reported more autonomous forms of self-regulation (identification and integration, $p \leq 0.001$) and higher perception of autonomy-promoting treatment climate ($p \leq 0.001$), internal locus of causality for exercise ($p \leq 0.001$), exercise perceived competence and intrinsic motivation ($p \leq 0.001$), and psychological and fitness exercise motives ($p \leq 0.01$). Effect sizes for theoretical mediators ranged between 0.38 and 1.38 ($p \leq 0.01$), favoring intervention. Key theoretical mediators also distinguished weight loss success groups ($> -2\%$ vs. $\leq -5\%$ of initial weight, $p \leq 0.001$).

Conclusions: This SDT- and MI-based intervention significantly impacted central theoretical mediators. Importantly, results clearly support the use of SDT for weight management, particularly through its effect on exercise-related constructs; more self-determined motivation and more autonomous forms of self-regulation predicted greater weight loss success at 1 year. Subjects are now being followed for 2 additional years, to assess weight maintenance results.

Other Publications

International

Silva MN, Markland D, Vieira PN, Coutinho SR, Carraça EV, Palmeira AL, Sardinha LB, Teixeira PJ. Exercise autonomous motivation and physical activity mediate 3-year weight change in overweight and obese women. Fourth International Self-Determination Theory Conference. Ghent, Belgium.

Purpose: Self-determination theory (SDT) has not been previously applied to weight management in long-term, controlled designs. The aim of this study was analyzing the extent to which perceived contextual need support, behavioral exercise regulations (12- and 24-

month), and physical activity (24-month) mediate the impact of an SDT-based intervention on 36-month weight change.

Methods: Longitudinal randomized controlled trial, consisting of a 1-year SDT-based intervention and a 2-year follow-up with 221 female participants (37.6 ± 7 y; 31.6 ± 4.1 kg/m² BMI). Model testing was conducted using partial least squares (PLS) analysis. Where there were significant intervening paths, tests of mediation were conducted.

Results: The model explained 19-96% of the variance in the target variables. Treatment had indirect effects on 12- and 24-month autonomous self-regulation, 24-month physical activity, and 36-month weight loss, fully mediated by the tested paths (effect ratios: 0.10 - 0.61). Perceived support had indirect effects on 24-month autonomous self-regulation and physical activity, fully mediated by the tested paths (effect ratios truncated at 1.0). Twelve-month autonomous self-regulation had indirect effects on 24-month physical activity, mediated by 24-month autonomous self-regulation (effect ratio 0.81), and indirect effects on 36-month weight loss, partially mediated by both 24-month autonomous self-regulation and physical activity (effect ratio 0.33). The 24-month autonomous self-regulation effects on 36-month weight loss were partially mediated by physical activity (effect ratio 0.42).

Conclusions: This application of SDT to physical activity and weight management provides experimental evidence that an autonomy-supportive context facilitates the internalization of regulatory processes which promote long-term behavioral and clinical outcomes in overweight/obese participants.

Silva, M.N., Vieira, P.N., Carraça, E.V., Palmeira, A., Coutinho, S.R., Santos, T., Sardinha, L.B. e Teixeira, P.J. (2009). Promoting autonomy and intrinsic motivation for physical activity in overweight and obese women. The 8th Annual Conference of the International Society for Behavioral Nutrition and Physical Activity. ISBNPA. FMH Edições Lisbon, Portugal

Purpose: Research on treatment-induced mediators of behavior change may be of help in identifying potential causal mechanisms through which interventions operate. Outcome-focused RCTs provide an excellent opportunity for such work. This presentation will identify critical mediators of change and provide an evidence-based examination of changes in physical activity (PA) and in psychosocial mechanisms of PA adherence during an obesity treatment intervention based on Self-Determination Theory (SDT).

Methods: 239 women were assigned to intervention and control groups. Assessments included exercise intrinsic motivation-IM, locus of causality-LC, autonomous self-regulation-ASR, psychological motives-PM; and PA: steps/day, moderate+vigorous PA, and lifestyle activity. Mediation and indirect effects were tested following Preacher and Hayes (2007).

Results: At 12 months (86% retention), the intervention significantly changed SDT putative mediators (ES=0.60-1.08) and increased PA (+147 min/wk moderate+vigorous PA; +1986 steps/day, ES=0.89 for a lifestyle activity index, and weight loss (-5.6%, $p < 0.001$ vs. controls). Results of the mediated models provide sound insights into the process underlying associations between intervention effects and PA sustained change, and are consistent with autonomous self-regulation and intrinsic motivation resting within the causal path of exercise adherence during weight control.

Conclusions: Research on interventions examining the effectiveness of self-determined approaches to changing exercise behaviors allows theory development and testing as well as the identification of possible causal mechanisms of intervention work. Taken collectively, the results of this and previous studies provide support for the application of SDT-framework to enhance our understanding of motivational processes as they relate to physical activity, specifically in the context of weight management.

Silva M.N., Teixeira P.J., Vieira P.N., Castro, M.M., Minderico C.S., Coutinho C.S., Santos, T.C., Palmeira A.L., Markland D, Sardinha L.B. (2008) Exercise Intrinsic Motivation, Autonomous Self-Regulation, and Psychological Motives as Mediators of Physical Activity During Weight Management. *International Society for Behavioral Nutrition and Physical Activity: Banff, Canada. ISBNPA*

Purpose: To analyse the role of exercise intrinsic motivation (IM), locus of causality (LC), autonomous self-regulation (ASR), and psychological motives (PM) as mediators of physical activity (PA) during an obesity treatment program based on Self-Determination Theory (SDT).

Methods: 255 women (37.5 ± 7.1 y; 31.6 ± 4.2 kg/m²) participated and were assigned to intervention/control groups. The intervention (30 weekly sessions) was specifically designed to increase PA, following SDT principles. Controls received a general health education program. Assessments included putative SDT mediators and PA: walking, moderate+vigorous PA (7-day PAR), and lifestyle PA. Multiple regression was used to test for mediation, as forwarded by Baron and Kenny. Indirect/mediated effects were tested using procedures described by Preacher and Hayes (2007).

Results: The intervention significantly changed all putative SDT mediators ($p < 0.001$) and increased PA (moderate+vigorous, lifestyle PA, $p < 0.001$; walking, $p = 0.017$). In the mediated models through IM, LC, ASR, and PM the intervention direct effects on moderate-vigorous and lifestyle PA were reduced but remained significant. Significant ($p < 0.05$) indirect effects were observed through all 4 SDT variables, suggesting partial mediation. For walking, only psychological motives (i.e., enjoyment, challenge, energy) partially mediated intervention effects.

Conclusions: The utility of mediation analysis in interventions stems from its ability to go beyond the descriptive to a more functional understanding of the true mechanisms of psychological and behavioral change. The present results are consistent with autonomous self-regulation and intrinsic motivation resting within the causal path of exercise adherence during weight control. Furthermore, they support SDT as a promising theoretical framework to promote health behavior change.

Silva, MN., Vieira, P.N., Minderico, C.S., Castro, M.M, Coutinho, S., Santos, T.C., Teixeira, P.J. (2007). Testing a Portuguese Self-Determination Theory-based Psychometric battery. *International Society for Behavioral Nutrition and Physical Activity: Oslo, Noruega. ISBNPA*

Purpose: The purpose of this study was to assess the factorial and concurrent validity of a comprehensive Portuguese battery of psychometric instruments grounded on Self-Determination Theory (SDT).

Methods: Subjects were 132 women (age, 37.2 ± 7.5 y), participating on a novel weight management program based on SDT. They completed Portuguese versions of SDT-based questionnaires: General Causality Orientations Scale (GCOS), Self-Determination Scale (SDS), Self-Motivation Inventory (SMI), Health Care Climate Questionnaire (HCCQ), Treatment Self-Regulation Questionnaire (TSRQ), Locus of Causality for Exercise (LCE) Self-Regulation Questionnaire for Exercise (SRQ-E), and Intrinsic Motivation Inventory (IMI). To assess scales' internal consistency and factorial structure, Cronbach's Alpha reliability coefficients and exploratory factor analyses were performed. Secondly, correlations were conducted between scales, following SDT tenets, to evaluate concurrent validity.

Results: Results for HCCQ, LCE, SDS, SMI, and TSRQ provided evidence for validity, internal consistency, and reliability of the underlying constructs (alphas: .80 to .96). Inspection of rotated factor matrices for GCOS, TSRQ, SRQ-E and IMI detected items loading weakly on the expected factor. Item removal yielded a higher internal consistency (alphas: .74 to .93) and stronger factorial structure. Correlation patterns among questionnaires strongly supported the expected relationships. General causality orientations and self-determination measures were significantly inter-correlated (r from .26 to .88; $p < 0.01$) and exercise-related instruments (IMI, LCE, SRQ-E) also matched expected associations patterns (r from .24 to .90; $p < 0.01$).

Conclusions: The SDT-based instruments proved valid, internally consistent, and reliable; associations clearly supported concurrent validity of these measures. It is now possible to adequately test SDT and related exercise motivation measures in Portuguese-speaking individuals.

Silva, M.N., Vieira, P.N., Minderico, C.S., Castro, M.M., and Teixeira, P.J. (2007). A Randomized Controlled Trial of Behavioral Weight Control Based on Self-Determination Theory: Change in Putative Mediators and Body Weight. Third International Self-Determination Theory Conference. Toronto, Canada

Goals: While tested before for other health behaviors with promising results, SDT has never been experimentally evaluated for weight management. This study aims at describing a novel treatment for obesity, centered on physical activity (PA) and based on Self-Determination Theory (SDT), and analyzing change in exercise-related mediators and weight loss, in an ongoing 3-year trial.

Methods: A total of 257 overweight/obese females were randomized into intervention/control groups and started the program thus far. It consists of 30 group meetings covering PA, eating/nutrition, body image, and other cognitive and behavioral contents. Central to the intervention model are autonomy, intrinsic motivation, and self-regulation of behavior change. Autonomy-supportive treatment climate and internal causality orientations are predicted to enhance autonomous regulation, perceived competence, and intrinsic motivation for the targeted behaviors, resulting in lasting behavioral and body weight changes. Assessments for this study include SDT-relevant psychological moderators and mediators and body weight.

Results: In the first two of three cohorts (n=169, age=37.2 ± 7.5 yrs, BMI= 31.8 ± 4.1 kg/m²) different data analyses (intervention vs. control effect size; correlation coefficients between SDT variables and weight change; comparison among success groups) confirm the usefulness of SDT for weight control, particularly through its effect on exercise-related constructs. Perceptions of autonomy treatment climate, more self-determined motivation, and more autonomous forms of self-regulation predicted greater success.

Conclusions: The SDT-based intervention was successfully implemented, resulting in significant and clinically-meaningful changes, and offering empirical support of its efficacy by impacting central theoretical mediators such as enjoyment, competence and an internal, more autonomous type of self regulation.

Silva, MN., Vieira, P., Minderico, C., Castro, M., Teixeira “Change in body weight and psychosocial mediators from self determination theory during behavioural obesity treatment” International Society for Behavioral Nutrition and Physical Activity ,Boston, July 2006

Purpose: The goal of this study was to analyze 12-month change in exercise-related psychosocial mediators and their impact on weight loss, in an RCT to test Self-Determination Theory (SDT) in weight management.

Methods: 104 women (age, 36.9±7.6 y; BMI, 31.2±4.2 kg/m²) were assigned to intervention/control groups. The intervention group attended 30 weekly sessions designed to follow SDT, with an emphasis on promoting intrinsic, self-regulated motivation for exercise and weight control. Assessments included treatment climate (autonomy- vs. control-supportive), and several SDT variables adapted to the exercise domain (exercise motivation, causality orientations, behavioral self-regulation).

Results: At 12 months, compared to controls, the intervention group (87% retention) showed more autonomous self-regulation (identification, integration, p<0.001), more psychological and fitness exercise motives (p=0.017), and higher exercise perceived competence (p=0.018). Treatment climate (p=0.004), locus of causality (p=0.004), intrinsic motivation (p=0.007), psychological motives (p=0.040), and autonomous self-regulation (p=0.004) were associated with 12-month weight loss, in some cases independent of 4-month weight and randomization group. Exercise intrinsic motivation (p=0.005) and locus of causality (p=0.024) distinguished successful (>5% weight loss) from non-successful participants.

Conclusions: This SDT-based intervention significantly impacted key theoretical mediators. Importantly, results clearly support the use of SDT for weight management, particularly through its effect on exercise-related constructs; more self-determined motivation and more autonomous forms of self-regulation predicted greater success at 1-year. Assuring that overweight women take on physical activity that they enjoy, feel competent at, and can self-regulate in an autonomous fashion may be key factors for success in weight control.

Silva, MN., Vieira, P., Minderico, C., Castro, M., Teixeira, “A Randomized Controlled Trial of Behavioral Weight Control Based on Self-Determination Theory in Women”. International Society for Behavioral Nutrition and Physical Activity , Amesterdão. June 2005

Purpose: The goals of this study were to describe an obesity treatment program for women based on Self-Determination Theory (SDT) and report on its initial impact on several theory-driven mediators.

Methods: 104 women (age, 36.9 ± 7.6 y; BMI, 31.2 ± 4.2 kg/m²) were assigned to intervention/control groups. Controls received a general health education curriculum while the intervention group attended 16 weekly sessions designed to follow SDT, with a special emphasis on promoting intrinsic, self-regulated sources motivation for exercise and weight control. Psychometric assessments included general causality orientations, perceptions of treatment climate (autonomy- vs. control-supportive), and several SDT variables adapted to the exercise domain (motivation characteristics, causality orientations, behavioral self-regulation).

Results: At 4-months, compared to controls (79% retention), women in the intervention group (96% retention) perceived the intervention as being more autonomy-supportive ($p < .001$) and reported higher exercise perceived competence ($p = .007$). Women attending the SDT program also displayed more psychological motives for participating in physical activities (particularly in the *enjoyment* ($p = .036$) and *challenge* ($p < 0.001$) dimensions), higher scores on body- and fitness-related motives ($p < 0.05$), and higher levels of introjected ($p = .005$), identified ($p = .018$), and integrated ($p = .005$), but not external ($p = .133$) types of exercise self-regulation. No group differences were observed for exercise locus of causality ($p = .134$).

Conclusions: Results offer empirical support to the effectiveness of the intervention in impacting central SDT mediators such as enjoyment, competence, and an internal, more autonomous type of self-regulation. Further investigation will evaluate longer-term results and assess the association of SDT-based predictors with exercise and eating behaviors, weight loss, and psychological well-being.

Questionnaires used in the Thesis

Health Care Climate Questionnaire

Questionário de Clima de intervenção

Este questionário contém afirmações relacionadas com o que sente em relação à equipa do Programa PESO. O objectivo é avaliar como se sente em relação à sua participação e à atitude dos técnicos deste programa. As suas respostas são confidenciais e pode escolher qualquer número entre 1 e 7. Por favor seja o mais honesta possível.

	Discordo Completamente					Não Concordo nem Discordo				Concordo Completamente
1. Sinto que a equipa me tem proporcionado escolhas e diversas opções durante o programa até agora.	1	2	3	4	5	6	7			
2. Sinto que equipa me compreende.	1	2	3	4	5	6	7			
3. Sinto que sou capaz de me abrir com a equipa, nas nossas reuniões.	1	2	3	4	5	6	7			
4. A equipa demonstra confiança na minha capacidade para mudar.	1	2	3	4	5	6	7			
5. Sinto que a equipa me aceita como eu sou.	1	2	3	4	5	6	7			
6. A equipa assegurou-se de que eu realmente compreendo o meu problema e o que tenho de fazer para lidar com ele.	1	2	3	4	5	6	7			
7. A equipa encoraja-me a colocar as minhas dúvidas.	1	2	3	4	5	6	7			
8. Sinto bastante confiança na equipa do programa.	1	2	3	4	5	6	7			
9. A equipa tem respondido às minhas dúvidas de forma completa e cuidadosa.	1	2	3	4	5	6	7			
10. A equipa ouve o meu lado, a forma como eu gostaria de fazer o que tenho de fazer.	1	2	3	4	5	6	7			
11. A equipa tem lidado com as emoções das participantes bastante bem.	1	2	3	4	5	6	7			
12. Sinto que a equipa se interessa por mim enquanto pessoa.	1	2	3	4	5	6	7			
13. Não me sinto muito bem com a forma que os membros da equipa falam comigo.	1	2	3	4	5	6	7			
14. A equipa tenta perceber a minha visão das coisas antes de propor novas formas de acção.	1	2	3	4	5	6	7			
15. Sinto-me capaz de partilhar os meus sentimentos com a equipa do Programa PESO.	1	2	3	4	5	6	7			

Self-Determination Scale

Escala de Auto-Determinação

As seguintes afirmações que estão agrupadas aos pares. Por favor, leia um par de cada vez, e decida qual das duas afirmações lhe parece mais próxima de si, nesta altura da sua vida. Assinale a sua escolha na escala de 5 pontos: 1 corresponde ao facto de só a afirmação A ser verdadeira para si e o 5 corresponde ao facto de só B ser verdadeiro para si. O 3 representa a pontuação se as duas afirmações lhe parecerem igualmente verdadeiras. Pode escolher qualquer número entre 1 e 5.

1. A) Sinto que sou sempre eu a escolher aquilo que faço

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Por vezes sinto que não sou realmente eu a escolher aquilo que faço

2. A) Por vezes sinto emoções que me são estranhas

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) As emoções que sinto são sempre minhas

3. A) Faço tudo o que tenho que fazer por escolha própria

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Eu faço tudo o que tenho que fazer, mas não sinto que seja realmente escolha minha

4. A) Sinto que raramente sou eu própria

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Sinto que posso sempre ser eu própria

5. A) Eu faço aquilo que faço porque me interessa

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Eu faço aquilo que faço porque tenho de o fazer

6. A) Quando consigo algo, é frequente sentir que realmente não foi obra minha

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Quando consigo algo, sinto que fui eu própria que o consegui

7. A) Sinto-me livre para fazer o que quer que decida fazer

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Frequentemente, o que faço não é aquilo que faria se pudesse escolher

8. A) Por vezes sinto que o meu corpo me é estranho

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Sinto sempre que o meu corpo é aquilo que eu sou

9. A) Sinto-me bastante livre para fazer aquilo que escolhi fazer

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Frequentemente faço coisas que não escolhi ter que fazer

10. A) Por vezes, quando olho ao espelho, vejo uma estranha

Só A) é verdadeira 1 2 3 4 5 Só B) é verdadeira

B) Quando me olho ao espelho vejo-me a mim mesma

Treatment Self-Regulation Questionnaire

Questionário de Auto-Regulação para o tratamento

As seguintes afirmações referem-se a possíveis motivos para continuar a participar num programa de controlo do peso. Diferentes pessoas poderão apresentar diferentes razões para continuarem no programa. Neste sentido, ao ler as afirmações constantes neste questionário, deve considerar até que ponto elas são verdadeiras para si. Não há respostas certas ou erradas.

Nota: Para cada grupo de questões (A e B), deve responder a todas as afirmações.

A. Mantenho-me como participante neste programa de controlo do peso porque:

1.	Me sentiria mal comigo própria se não o fizesse						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
2.	Outros ficariam zangados comigo se não o fizesse						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
3.	Me sentiria uma pessoa falhada se não continuasse						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
4.	Acredito que o programa é a melhor forma de me ajudar a mim própria						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
5.	Outros pensariam que sou uma pessoa fraca se não o fizesse						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
6.	Eu <u>decidi</u> não desistir deste programa						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
7.	É um desafio para mim procurar atingir o meu objectivo						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
8.	Investi demasiado dinheiro neste programa para desistir						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7

B. Tenho seguido as orientações do programa porque:

9.	Acredito que estas orientações me têm ajudado a resolver o meu problema						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
10.	Receio entrar em conflito com a equipa de intervenção se não seguir todas as orientações						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
11.	Quero que os outros vejam que eu estou realmente a tentar perder peso						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7

Treatment Self-Regulation Questionnaire (cont.)

Questionário de Auto-Regulação para o tratamento

12.	É importante para mim atingir os meus objectivos						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7
13.	Sinto-me culpada se não cumprir todas as orientações						
	Nada verdadeiro			Moderadamente verdadeiro			Totalmente verdadeiro
	1	2	3	4	5	6	7

Intrinsic Motivation Inventory

Inventário de Motivação Intrínseca

Por favor, responda a todas as questões da forma que melhor se aplica a si. Em cada uma delas existem cinco hipóteses de escolha.

	DISCORDO FORTEMENTE	DISCORDO	NÃO ESTOU SEGURA	CONCORDO	CONCORDO FORTEMENTE
1. Eu descrevo a Actividade Física como muito interessante	1	2	3	4	5
2. Acho que até sou bastante bom/a a praticar Actividade Física, comparado com outros	1	2	3	4	5
3. Esforço-me bastante nas Actividades Físicas	1	2	3	4	5
4. Sinto-me muito tenso/a por ter de praticar Actividade Física	1	2	3	4	5
5. É divertido praticar Actividade Física	1	2	3	4	5
6. Sinto-me muito competente depois de praticar Actividade Física durante algum tempo	1	2	3	4	5
7. Para mim é importante ter um bom desempenho na Actividade Física	1	2	3	4	5
8. Sinto-me pressionado/a pela ideia de fazer Actividade Física	1	2	3	4	5
9. Divirto-me muito quando me encontro em Actividade Física	1	2	3	4	5
10. Tenho bastante aptidão para a maioria das Actividades Físicas	1	2	3	4	5
11. Empenho-me bastante nas Actividades Físicas	1	2	3	4	5
12. Quando pratico Actividade Física geralmente sinto-me ansioso/a	1	2	3	4	5
13. As Actividades Físicas normalmente não costumam prender a minha atenção	1	2	3	4	5
14. Não me saí muito bem na última vez que tentei fazer Actividade Física	1	2	3	4	5
15. Geralmente não me esforço para fazer Actividade Física	1	2	3	4	5
16. Normalmente sinto-me descontraído/a ao fazer Actividade Física	1	2	3	4	5

Locus of Causality for Exercise

Locus de causalidade para o exercício

1 – Eu faço actividade física porque gosto e não porque sinto que sou obrigado/a.

Discordo Absolutamente 1	Discordo Moderadamente 2	Discordo um pouco 3	4	Concordo um pouco 5	Concordo Moderadamente 6	Concordo Absolutamente 7
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2 – Exercício não é algo que eu escolha para fazer, antes é algo que sinto que tenho obrigação de fazer

Discordo Absolutamente 1	Discordo Moderadamente 2	Discordo um pouco 3	4	Concordo um pouco 5	Concordo Moderadamente 6	Concordo Absolutamente 7
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3 – Ter que realizar exercício é um fardo, mas é algo que tem de ser feito.

Discordo Absolutamente 1	Discordo Moderadamente 2	Discordo um pouco 3	4	Concordo um pouco 5	Concordo Moderadamente 6	Concordo Absolutamente 7
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Self-Regulation Questionnaire-Exercise

Questionário de Auto-Regulação para o Exercício

Existem muitos motivos que levam a pessoa a fazer exercício regularmente. Por favor indique o grau com que cada um dos motivos seguintes o leva a fazer exercício regular.

	Nada Verdadeiro			Um Pouco Verdadeiro			Muito Verdadeiro
<u>Tento fazer exercício regularmente</u>							
1. Porque me sentiria mal comigo própria se não o fizesse.	1	2	3	4	5	6	7
2. Porque outras pessoas ficariam zangadas comigo se não o fizesse.....	1	2	3	4	5	6	7
3. Porque gosto de fazer exercício.	1	2	3	4	5	6	7
4. Porque me sentiria uma falhada se não o fizesse	1	2	3	4	5	6	7
5. Porque sinto que é a melhor maneira de fazer algo por mim própria	1	2	3	4	5	6	7
6. Porque os outros pensariam que sou uma pessoa fraca se não o fizesse.....	1	2	3	4	5	6	7
7. Porque sinto que não tenho alternativas acerca do exercício; outras pessoas obrigam-me a fazer	1	2	3	4	5	6	7
8. Porque é um desafio, a obtenção dos meus objectivos	1	2	3	4	5	6	7
9. Porque acredito que o exercício ajuda-me a sentir melhor.	1	2	3	4	5	6	7
10. Porque é divertido	1	2	3	4	5	6	7
11. Porque tenho receio de arranjar problemas com os outros se não o fizesse.	1	2	3	4	5	6	7
12. Porque sinto que é importante para mim alcançar os meus objectivos.....	1	2	3	4	5	6	7
13. Porque me sinto culpada se não fizer exercício regularmente	1	2	3	4	5	6	7
14. Porque quero que as outras pessoas saibam que estou a fazer o que me disseram que devia fazer.....	1	2	3	4	5	6	7
15. Porque é interessante ver o meu próprio desenvolvimento.....	1	2	3	4	5	6	7
16. Porque sentir-me mais saudável é importante para mim.	1	2	3	4	5	6	7

Motives for Exercise Scale-II

Escala de Motivos para o Exercício-II

Nas páginas seguintes encontram-se um conjunto de afirmações relacionadas com as **razões** que as pessoas frequentemente dão para **fazer exercício físico**. Independentemente de actualmente fazer exercício ou não, por favor leia cada afirmação cuidadosamente e indique, fazendo um círculo no número apropriado, se cada uma das afirmações é verdadeira ou falsa para si, ou se seria verdadeira para si se fizesse exercício físico. Se considera que uma afirmação **não é** de todo verdadeira para si, indique “0”. Se pensa que uma afirmação **é** “muito verdadeira” para si, assinale “5”. Se pensa que uma afirmação é parcialmente verdadeira para si, então assinale “1”, “2”, “3” ou “4”, de acordo com o grau de veracidade de cada afirmação para si. **Pode escolher qualquer número entre 0 e 5.**

Lembre-se p.f.: Queremos saber porque razões you própria escolhe ou escolheria fazer exercício, e não se considera que as afirmações constituem boas razões para outros fazerem exercício.

	Nada Verdade para mim	Muito Verdade para mim
Pessoalmente, eu faço exercício (ou faria exercício)		
1. Para manter-me magra.....	0	5
2. Para evitar doenças.....	0	5
3. Porque faz-me sentir bem.....	0	5
4. Para parecer mais jovem.....	0	5
5. Para demonstrar aos outros o meu valor.....	0	5
6. Para me dar tempo para pensar	0	5
7. Para ter um corpo saudável.....	0	5
8. Para ter mais força.....	0	5
9. Porque gosto da sensação de me exercitar.....	0	5
10. Para passar tempo com os amigos	0	5
11. Porque o meu médico aconselhou-me a fazer exercício.....	0	5
12. Porque gosto de tentar ganhar nas actividades desportivas	0	5
13. Para ser/tornar-me mais ágil.....	0	5
14. Para ter objectivos para atingir	0	5
15. Para perder peso	0	5
16. Para prevenir problemas de saúde	0	5
17. Porque acho que o exercício é revigorante	Nada Verdade para mim	Muito Verdade para mim
18. Para ter um bom corpo	0	5
19. Para comparar as minhas capacidades com as de outras pessoas.....	0	5
20. Porque ajuda a reduzir a tensão	0	5
21. Porque quero manter uma boa saúde.....	0	5
22. Para aumentar a minha resistência.....	0	5
23. Porque fazer exercício é gratificante em si mesmo	0	5
24. Para gozar os aspectos sociais do exercício.....	0	5
25. Para ajudar a prevenir uma doença que corre na minha família.....	0	5

Motives for Exercise Scale-II (cont.)

Escala de Motivos para o Exercício-II

- 1. Porque gosto de competir0 1 2 3 4 5
- 2. Para manter a flexibilidade nos meus músculos.....0 1 2 3 4 5
- 3. Para ter desafios para vencer.....0 1 2 3 4 5
- 4. Para ajudar a controlar o peso0 1 2 3 4 5
- 5. Para evitar doenças do coração0 1 2 3 4 5
- 6. Para “recarregar as baterias”0 1 2 3 4 5
- 7. Para melhorar a minha aparência0 1 2 3 4 5
- 8. Para ser reconhecido pelos meus feitos.....0 1 2 3 4 5
- 9. Para ajudar a controlar o stress.....0 1 2 3 4 5
- 10. Para me sentir mais saudável.....0 1 2 3 4 5
- 11. Para ser mais forte fisicamente.....0 1 2 3 4 5
- 12. Para gozar a experiência de fazer exercício0 1 2 3 4 5
- 13. Para me divertir e ser activa com outras pessoas0 1 2 3 4 5
- 14. Para me ajudar a recuperar de uma doença ou lesão.....0 1 2 3 4 5
- 15. Porque gosto da competição física ou desportiva0 1 2 3 4 5
- 16. Para ser/tornar-me mais flexível (para ficar com músculos mais flexíveis)0 1 2 3 4 5
- 17. Para desenvolver competências pessoais0 1 2 3 4 5
- 18. Porque o exercício me ajuda a queimar calorias.....0 1 2 3 4 5
- 19. Para parecer mais atraente.....0 1 2 3 4 5
- 20. Para conseguir coisas que os outros não são capazes.....0 1 2 3 4 5
- 21. Para aliviar a tensão.....0 1 2 3 4 5
- 22. Para desenvolver os músculos.....0 1 2 3 4 5
- 23. Porque me sinto no meu melhor quando me exercito0 1 2 3 4 5
- 24. Para fazer novos amigos.....0 1 2 3 4 5
- 25. Porque as actividades físicas são divertidas especialmente quando envolve
competição.....0 1 2 3 4 5
- 26. Para me comparar comigo mesma.....0 1 2 3 4 5

Lifestyle Physical Activity

As questões seguintes descrevem actividades do dia-a-dia. P.f. indique quantas vezes, **no último mês**, escolheu cada uma das actividades descritas.

1. **Subir escadas** em vez de utilizar elevadores ou escadas rolantes (p.ex. no seu prédio, em centros comerciais, no local de trabalho, etc.)

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

2. Escolher **estar em pé** em situações **em que podia estar sentado/a** (p.ex. em casa, enquanto fala ao telefone, enquanto espera em locais públicos, espera pelo transporte, etc.)

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

3. Escolher **caminhar** quando habitualmente costumava ir de carro ou transportes (p.ex. ir às compras, deslocar-se no bairro ou em percursos pequenos equivalentes a 5-10 min de carro, ir aos correios ou à farmácia, etc.)

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

4. **Estacionar o carro** num local **mais distante** da entrada (p.ex. centros comerciais, lojas, cinema, trabalho, etc.) para poder caminhar mais até à entrada

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

5. Escolher fazer **manualmente** o que antes fazia com auxílio de máquinas automáticas (p.ex. lavar o carro, lavar janelas, etc.)

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

6. Fazer pausas durante o **trabalho** ou utilizar os intervalos do trabalho para **caminhar ou movimentar-se mais** (p.ex. caminhar até o restaurante, caminhar para entregar uma mensagem ao colega de trabalho em vez de enviar via e-mail ou telefonar, escolher um WC mais distante do lugar onde trabalha em vez do mais próximo, etc.)

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

7. Escolher **caminhar** ou outra forma activa quando é forçado/a a esperar em circunstâncias diárias (esperar por alguém, esperar para ser atendido, durante os anúncios da TV)

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

8. Existem **outras situações** em que escolhe ser **fisicamente mais activo/a**, quando podia facilmente gastar menos energia? Se sim indique em baixo, p.f.

Descreva a situação: _____

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível

Descreva a situação: _____

Nunca Poucas vezes Algumas vezes Muitas vezes Sempre que possível