Níveis de Atividade Física e Comportamentos de Risco em Crianças. O Estudo ISCOLE em Portugal.

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Palavras-chave: Atividade física, Obesidade, Classes de risco, Comportamentos de risco, Crianças.

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It always seems impossible until it's done
Nelson Mandela (1918-2013)

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ÍNDICE GERAL

ÍNDICE DE TABELAS

Capítulo 1

Capítulo 2

Capítulo 3

ÍNDICE DE FIGURAS

Capítulo 2

Capítulo 3

RESUMO

Hábitos nutricionais, atividade física (AF), tempo de sono e de ecrã são comportamentos associados a doenças não transmissíveis, como a hipertensão arterial, diabetes tipo II, doenças cardiovasculares e obesidade. Evidências sugerem que grande parte das crianças não cumpre as recomendações de saúde nestes comportamentos. Os principais objetivos desta pesquisa são: (i) descrever a relação entre comportamentos de saúde em crianças Portuguesas e (ii) estimar o efeito de características individuais e sociodemográficas em perfis multivariados destes comportamentos. A amostra é constituída por 777 crianças portuguesas, com idades entre 9-11 anos, provenientes de 23 escolas do grande Porto, que fazem parte do projeto ISCOLE (International Study of Childhood Obesity, Lifestyle and the Environment). As variáveis estudadas são: altura, peso, composição corporal, índice de massa corporal (IMC), maturação biológica, AF, hábitos nutricionais, tempo de sono e ecrã. As estatísticas descritivas foram calculadas no software SPSS 20.0. As variações diárias de AF moderada a vigorosa (AFMV), e as suas correlações foram modeladas no *software* HLM 7.0. O *tracking* foi calculado através de dois procedimentos: auto-correlações [(r) Stata 13] e γ Foulkes & Davies (Timepath). Os perfis de risco foram explorados no *software* CFA, e o *software* Mplus 6 foi utilizado para estimar classes latentes de comportamentos de risco. Os resultados mostram que cerca de 46% das crianças apresentam sobrepeso/obesidade; 51.3% dos rapazes e 26.2% das raparigas cumprem as recomendações diárias de AFMV, sendo evidente uma tendência não linear no cumprimento das recomendações ao longo de uma semana, marcada por uma acentuada diminuição ao fim de semana. Observou-se um tracking fraco nos rapazes (r=0.37; γ=0.59±0.01) e nas raparigas (r=0.32; γ=0.56±0.01). A frequência de crianças que consumem refrigerantes açucarados menos de 2 vezes por semana é de 64.7% e, 28.7% comem frutas e vegetais todos os dias. 36.6% da amostra cumpre as recomendações para o tempo de ecrã e 7.3% dorme mais de 10 horas por dia. Cerca de 80% acumula três ou mais comportamentos de risco, sendo que apenas 0.2% não apresenta

qualquer risco. Emergiram duas classes latentes: classe 1 (ativos, comportamentos sedentários e dieta pobre) e classe 2 (inativos mas boa dieta); esta última, a mais prevalente (≈65%), caracterizada pela inatividade física, tempo de sono reduzido e baixo consumo de refrigerantes açucarados, é onde as raparigas, as crianças com sobrepeso/obesidade, e cujas mães apresentam níveis mais elevados de escolaridade têm maior chance de serem classificados ($p<0.05$). Conclui-se que: (i) o cumprimento das recomendações de AFMV ao longo de uma semana apresenta um carácter instável; (ii) os rapazes são mais ativos que as raparigas; (iii) as crianças obesas apresentam maior risco de não cumprirem as recomendações para um estilo de vida saudável; (iv) uma percentagem elevada agrega comportamentos de risco para a sua saúde.

Palavras-chave: ATIVIDADE FÍSICA, OBESIDADE, CLASSES DE RISCO, COMPORTAMENTOS DE RISCO, CRIANÇAS

ABSTRACT

Nutritional habits, physical activity (PA), sleep and screen time are behaviors related with beneficial effects on non-transmissible diseases, namely hypertension, type II diabetes, and obesity. However, available research reported that the majority of children do not meet health recommendations regarding these behaviors. Therefore, this study aims: (i) to describe the complex relationship between health behaviors in 10-year-old Portuguese children; and (ii) to estimate the effect of individual and socio-demographic characteristics on behavior profiles.

The sample comprises 777 Portuguese children aged 9-11 years, from 23 Oporto schools, involved in the ISCOLE (International Study of Childhood Obesity, Lifestyle and the Environment) project. Included variables are: height, weight, body composition, body mass index (BMI), biological maturation, PA, sleep and screen time and nutritional habits. Descriptive statistics were calculated in SPSS 20. Daily variations of moderate-to-vigorous PA (MVPA) and its correlates were modeled with a multilevel approach using HLM 7.0. Tracking was calculated in two different ways: auto-correlations in STATA 13 and Foulkes & Davies γ in Timepath. Risk behavior configurations were explored in CFA. Finally, *Mplus* software, version 6, was used to estimate latent classes of risk behaviors. Results: About 46% of children are overweight/obese; 51.3% of boys and 26.2% of girls meet the daily recommendations for MVPA. The compliance with the recommendations showed a nonlinear trend with a marked reduction towards the weekend. Normal-weight children were more active than obese children. Autocorrelations and tracking are low in both boys ($r=0.37$; $\gamma=0.59\pm0.01$) and girls ($r=0.32$; $\gamma=0.56\pm0.01$). The prevalence of children who consume less than 2 times per week sugary drinks is 64.7%, as 28.7% eat fruits and vegetables daily. In our sample, 36.6% meet the recommendations for screen time, and 7.3% sleep over 10 hours per day. About 80% accumulates three or more risk behaviors, and only 0.2% has no risk. Two consistent and significant latent classes were identified. The most prevalent (≈65%) is characterized by physical inactivity, reduced sleep time and

lower consumption of sugary drinks, in which girls, children's with overweight/obesity, and whose mothers have a higher level of education are more likely to be classified. Conclusions: (i) compliance with the recommendations of MVPA over a week show a highly unstable character; (ii) boys are more active than girls; (iii) obese children had higher risk of not meeting the recommendations; and (iv) a high percentage of children has combined risk behaviors.
Keywords: PHYSICAL ACTIVITY, OBESITY, CLASSES OF RISK, BEHAVIORS RISK, CHILDREN

LISTA DE ABREVIATURAS E SÍMBOLOS

IMC – Índice de massa corporal

BMI – Body mass índex

OMS – Organização Mundial de Saúde

WHO – World Health Organization

AFMV – Atividade física moderada a vigorosa

MVPA – Moderate-to-vigorous Physical Activity

PHV – Peak Height Velocity

SES – Socioeconomic status

FFQ – Food Frequency Questionnaire

CFA – Configural Frequency Analysis

SQRT_MVPA – Square root moderate-to-vigorous physical activity

Me - Median

M – Mean

SD – Standard Deviation

Q - Quartile

Kg – Kilogram

BLR - Bootstrap likelihood ratio test

Min – Minimum

Max – Maximum

OR – odds ratio

AIC – Akaike information criteria;

BIC – Bayesian AIC

IQR – interquartile range

$kg \cdot m^2$ – kilogram per meter square

L-M-R LRT –Lo-Mendell-Rubin likelihood ratio test

P – percentile

γ – Gama of Foulkes & Davies

χ^2 – Qui-square

≥ - Higher or equal to

± - approximately

< - Lower than

> - Higher than

% - Percentage

p – proof-value

Min/day – minutes per day

$min \cdot d^{-1}$ – minutes per day

h/night – hours per night

h/day – hours per day

$CI_{95\%}$ – confidence interval

fo – observed frequency

fe – expected frequency

Capítulo 1

Introdução Geral e Estrutura da Dissertação

INTRODUÇÃO GERAL

A obesidade é atualmente definida como uma doença complexa, de natureza multifactorial, que resulta do desequilíbrio entre a ingestão calórica excessiva e o parco consumo energético (Malina, Bouchard, & Bar-Or, 2004) culminando na acumulação de gordura corporal em quantidades lesivas para o bem-estar. Este estado compromete a saúde dos indivíduos, constituindo-se como um fator de risco para o desenvolvimento de outras doenças crónicas, nomeadamente as de foro cardiovascular, diabetes tipo II e alguns tipos de cancro (Segel, 2011).

Segundo a Organização Mundial de Saúde (OMS), os fatores de risco para desenvolvimento prematuro de doenças não transmissíveis (como a hipertensão arterial, diabetes tipo II, doenças cardiovasculares, ou obesidade), responsáveis por dois terços da mortalidade a nível mundial (World Health Organization, 2011), são de natureza comportamental, nomeadamente decorrentes de maus hábitos alimentares (baixo consumo de frutas e vegetais, e alta ingestão de gorduras e açúcares), inatividade física e sedentarismo.

Estima-se que cerca de 10% das crianças e jovens em idade escolar tenham excesso de peso, sendo que ¼ tem obesidade (Lobstein, Baur, & Uauy, 2004). Em Portugal, as prevalências de sobrepeso e obesidade oscilam entre 18.7%-30.4% e 5.8%-28.0%, respectivamente, variando de acordo com o sexo e diferentes pontos de corte (Figueiredo et al., 2013; Plataforma Contra a Obesidade, 2009 ; Sardinha et al., 2011).

A etiologia da obesidade é multifactorial (Spruijt-Metz, 2011), envolvendo fatores de natureza biológica, comportamental e ambiental. Neste contexto, os investigadores em Saúde Pública têm procurado compreender a estrutura e dimensão dos fatores biológicos relacionados com a obesidade, associando-os ao estilo de vida, especialmente no que diz respeito ao binómio "dieta-atividade física". A sua atenção centra-se em aspectos associados ao aumento da ingestão calórica e aparente redução dos níveis de atividade física observados nas últimas décadas, em consequência das mudanças nos estilos de vida oriundas do processo de industrialização e robotização das sociedades

modernas (Belahsen, 2014; Cecchini et al., 2010; Prentice-Dunn & Prentice-Dunn, 2012; Rey-Lopez, Vicente-Rodriguez, Biosca, & Moreno, 2008)

Durante a infância e a adolescência, os jovens desenvolvem atitudes e padrões de comportamento de saúde sob a influência de diversos agentes, de natureza parental, familiar, escolar, media e pares, (Gruber & Haldeman, 2009; Maturo & Cunningham, 2013; Nicholls et al., 2014; Norton et al., 2003; Strasburger, Jordan, & Donnerstein, 2010; Verloigne et al., 2012) que são frequentemente canalizados (do termo "tracking ") até à idade adulta, aumentando o risco de desenvolvimento de doenças crónicas se não se configurarem como hábitos saudáveis (Malina, Bouchard, & Bar-Or, 2004). A infância e a adolescência são assim consideradas janelas importantes de oportunidade para a adoção e manutenção de comportamentos saudáveis, constituindo-se como períodos privilegiados para intervenções significativas de educação que visem a sua promoção (Jones, Hinkley, Okely, & Salmon, 2013).

Neste sentido, ao longo dos últimos anos, a OMS tem desenvolvido diretrizes com o objectivo de promover e proteger a saúde das crianças e jovens, orientando o desenvolvimento de um ambiente propício para ações sustentáveis, não só ao nível do indivíduo e da comunidade, mas também em termos nacionais e globais (World Health Organization, 2004). Em 2003, a OMS disponibilizou um documento designado por "*Diet, nutrition and the prevention of chronic diseases"* (World Health Organization, 2003), em que foi estabelecido o consumo de pelo menos 400g de frutas ou vegetais por dia como proteção para o desenvolvimento de doenças crónicas. Em 2010, estabeleceu a recomendação de 60 minutos de atividade física moderada a vigorosa (AFMV) por dia para crianças e jovens em idade escolar (5-17 anos) (World Health Organization, 2010) com vista à manutenção da saúde. No que diz respeito ao comportamento sedentário, tem sido sugerido que as crianças não devem gastar mais de duas horas por dia a ver televisão ou a jogar videojogos (Barlow, 2007), devido à sua associação positiva com o sobrepeso e/ou obesidade (Herman et al., 2014; Maher et al., 2012).

Uma outra linha de pesquisa que tem ocupado a investigação no domínio da obesidade infantil prende-se com o tempo de sono. Estudos recentes têm

encontrado evidências de que o tempo reduzido de sono é um fator de risco para o desenvolvimento de obesidade (Chaput et al., 2011; Nixon et al., 2008). Todavia, não existe consenso na literatura relativamente ao número de horas de sono recomendado para crianças em idade escolar, sendo que o seu valor oscila entre as 8.5 e as 11 horas (Matricciani et al., 2013). A *National Sleep Foundation* estabeleceu directrizes para o tempo de sono por dia em função da idade sugerindo que, para crianças entre os 5 e os 12 anos, uma noite de sono completa deverá conter entre 10 a 11 horas (National Sleep Foundation, 2013).

Nas últimas décadas têm sido produzidos diversos relatórios mostrando que um grande número de crianças não cumpre as recomendações descritas anteriormente (Black & Billette, 2013; Brusseau, Tudor-Locke, & Kulinna, 2013; Currie, 2004; Lock et al., 2005; Oliver et al., 2012; Rice, Quann, & Miller, 2013; Tornaritis et al., 2014). Além disso, também tem sido reportado que não existe um padrão regular nestes comportamentos, variando em função dos dias da semana (Carson, Stone, & Faulkner, 2014; Colley et al., 2013; Sandercock, Ogunleye, & Voss, 2012; Telford et al., 2013). De forma a compreender melhor este fenómeno, investigação recente tem utilizado o conceito de "classes latentes" para explorar o conjunto de variáveis comportamentais relacionadas com o estilo de vida e identificar grupos distintos de padrões de comportamento (Leech, McNaughton, & Timperio, 2014).

Em Portugal são escassos os estudos que abordam os fatores de risco comportamentais associando-os ao desenvolvimento de doenças não transmissíveis em crianças. Vasques et al. (2012) examinaram a associação entre o comportamento sedentário e a prevalência de sobrepeso e obesidade em crianças portuguesas entre os 6 e os 13 anos de idade e concluíram que apenas 12.2% despendem menos de 1.5 horas a ver televisão ou a jogar videojogos, e desses 75.4% têm sobrepeso e/ou obesidade. Estes autores reportaram ainda que apenas 21.8% das crianças caminham para a escola, embora não tenham encontrado efeitos significativos do tipo de transporte nas prevalências de sobrepeso e obesidade. Baptista et al. (2012) realizaram um estudo sobre a prevalência de portugueses que cumprem os 60 min de AFMV recomendados pela OMS, e concluíram que apenas 36% das crianças entre os

10 e 11 anos de idade são suficientemente ativas, sendo os rapazes mais ativos que as raparigas (51.6% e 22.5%, respectivamente). Contudo, nesta pesquisa não foi explorado o comportamento da Atividade física ao longo de uma semana, mas sim o comportamento da média semanal, não acautelando a hipótese da variabilidade dos comportamentos em função do dia da semana. Esta possibilidade foi demonstrada anteriormente num estudo com crianças e adolescentes europeus entre os 9 e 15 anos, tendo sido verificadas diferenças no tempo gasto em AFMV, entre os dias da semana e os do final de semana (Nilsson et al., 2009).

No que se refere à influência de vários fatores de risco comportamentais e características sociodemográficas sobre a prevalência de sobrepeso e obesidade em crianças, apenas um estudo (Bingham et al., 2013) foi identificado, tendo concluído que despender menos tempo a ver televisão e jogar videojogos, realizar mais de 1 hora de AFMV diariamente, e pertencer a famílias com níveis educacionais elevados, são fatores protetores do sobrepeso e obesidade infantis.

No entanto, em nenhum dos estudos reportados anteriormente foram analisadas as associações entre os vários comportamentos, as suas possíveis configurações, bem como a identificação de grupos distintos de comportamento com os fatores de risco que contribuem para o desenvolvimento prematuro de doenças não transmissíveis. A identificação da co-ocorrência de comportamentos de saúde e de perfis distintos é de extrema importância na educação para a saúde numa perspectiva de prevenção, pois possibilitará o estabelecimento de programas de intervenção melhor adequados num período crítico – a infância – na adoção e manutenção de comportamentos saudáveis que perdurem ao longo da vida.

PROJETO ISCOLE

Diferentes estudos multinacionais têm centrado a sua atenção na relação entre comportamentos de vida e a obesidade infantil (HBSC, HELENA, EYHS E IDEFICS) e têm vindo a demonstrar associações significativas entre os estilos de vida e a obesidade. Contudo, estas pesquisas circunscrevem-se a regiões

geográficas específicas (essencialmente na Europa), o que inviabiliza uma visão mais abrangente acerca dos efeitos de diferentes contextos na obesidade. Neste sentido, o *International Study of Childhood Obesity, Lifestyle and the Environment* (ISCOLE) ambiciona explorar estas relações em vários níveis e ambientes obesogénicos usando metodologias objectivas e auto-reportadas numa amostra multinacional de crianças de diversas origens culturais e socioeconómicas.

O projeto ISCOLE é um estudo transversal de natureza multinacional, com 6000 crianças, conduzido em 12 países (Austrália, Brasil, Canadá, China, Colômbia, Finlândia, India, Quénia, Portugal, África do Sul, Reino Unido e Estados Unidos), coordenado pelos Professores Doutores Peter Katzmarzyk e Tim Church do *Pennington Biomedical Research Center*, *Louisiana State University*, USA.

Os Objetivos principais são determinar a relação entre estilos de vida e obesidade em crianças entre os 9 e 11 anos de idade, e investigar a influência de características comportamentais, ambientes físicos, sociais e políticos nas associações observadas intra e entre países. Neste vasto projeto foram incluídos procedimentos de recolha de dados a nível individual (antropometria, estilo de vida, questionários de dieta e atividade física e acelerometria), ambiente escolar (questionário administrados aos diretores da escola), família e vizinhança (questionários parentais). Foi desenvolvido e implementado um sistema rigoroso de treino e certificação da equipa de recolha de dados, incluindo módulos de formação baseados na web e encontros regionais de treino dos protocolos [detalhes deste projeto podem ser encontrados em Katzmarzyk et al., (2013)].

ISCOLE EM PORTUGAL

O estudo em Portugal ficou a cargo do Laboratório de Cineantropometria e Estatística Aplicada da Faculdade de Desporto da Universidade do Porto, dirigido pelo Professor Doutor José António Ribeiro Maia e uma equipa de campo de 9 elementos. A amostra foi constituída por 777 crianças provenientes de 23 escolas da área do grande Porto. As recolhas de dados decorreram entre Setembro de 2011 e Fevereiro de 2013.

Inicialmente, foi realizado um levantamento das escolas existentes na Direcção Geral de Educação do Norte, seguida de uma escolha aleatória de 23 dessas escolas. Depois de escolhidas as escolas, foi elaborado um plano estratégico centrado, também, na especificação dos benefícios do projeto para a comunidade escolar. Primeiramente foi apresentado a um professor de educação física de cada escola e, de seguida, a todo o grupo de educação física. Após a obtenção do consentimento do grupo de educação física, o projeto foi apresentado à direcção de cada escola. Depois de aprovado pela direcção e conselho pedagógico, o mesmo foi apresentado à associação de pais para haver uma ligação forte com a comunidade escolar. De seguida, foi enviado um pedido de consentimento informado para todas as crianças que se encontravam na faixa etária pretendida. Recolhida esta informação, foi seleccionada uma amostra equilibrada de rapazes e raparigas. Após esta fase procedeu-se à calendarização das recolhas de dados por escola (uma semana por escola), bem como à preparação de todos os instrumentos de avaliação necessários. O contato com escolas, crianças e encarregados de educação foi permanente e, no final do estudo, foi enviado a cada escola um relatório com os principais resultados, bem como foi entregue a cada participante um relatório contendo informação sucinta sobre a sua avaliação.

OBJETIVOS

O presente estudo é percorrido pelos seguintes propósitos:

1) Descrever a relação entre comportamentos de saúde em crianças Portuguesas com 10 anos de idade;

2) Averiguar o cumprimento das recomendações para estilos de vida saudável;

3) Descrever a mudança ou estabilidade dos níveis de atividade física ao longo de uma semana das crianças;

4) Estimar o efeito de características individuais na variação diária dos níveis de atividade física;

5) Identificar a presença de perfis multivariados de comportamento de risco das crianças;

6) Estimar o efeito de características individuais e sociodemográficas nos perfis de comportamentos de saúde.

ESTRUTURA DA DISSERTAÇÃO

Este trabalho está organizado de modo distinto do padrão tradicional de elaboração de Dissertações de Mestrado, seguindo o "Modelo Escandinavo". A Dissertação é constituída por 4 capítulos, cuja estrutura está descrita na Tabela 1. Os capítulos dois e três correspondem aos artigos que foram redigidos seguindo as orientações e as normas específicas de cada periódico a que se submeteu e/ou intenciona submeter. As referências bibliográficas são apresentadas no fim de cada capítulo.

Tabela 1 – Capítulos da Dissertação e seus principais Objetivos.

Capítulo 1	Introdução geral, a relevância do estudo e os Objetivos da pesquisa.
Capítulo 2	**Change and stability in daily moderate-to-vigorous physical activity among 10 year old children.** This study aims (1) to identify daily MVPA trends of 10 year-old children achieving 60 minutes/day; (2) to model MVPA daily fluctuation levels, and estimate the effect of individual characteristics such as gender, body mass index (BMI), and maturity offset using multilevel modeling; (3) and to describe stability in children's daily MVPA using the approach suggested by Foulkes & Davies (1981). Artigo em revisão na *Annals of Human Biology* Pereira S, Gomes TN, Borges A, Santos D, Souza MC, Santos FK, Chaves RN, Barreira TV, Katzmarzyk PT, Maia JAR
Capítulo 3	**Profiling children physical activity, diet, screen and sleep habits in Portuguese Children** The purposes of this study are (1) to describe the profile configurations of risk behaviors; (2) to use latent class analysis to identify, based on maximum likelihood estimation techniques, the number of risk pattern classes, and (3) to estimate the joint effects of individual and socio-demographic characteristics in predicting risk class membership. Artigo em submissão à *Scandinavian Journal of Medicine & Science in Sports* Pereira S, Gomes TN, Borges A, Santos D, Souza MC, Santos FK, Chaves RN, Barreira TV, Katzmarzyk PT, Maia JAR
Capítulo 4	Síntese final e as conclusões gerais da Dissertação.

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Capítulo 2

Change and stability in daily moderate-to-vigorous physical activity among 10 year old children

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Artigo em revisão na Annals of Human Biology

Abstract

Background: Children physical activity levels do not show a consistent pattern of change across days or over the years.

Aim: To analyze stability and change of children daily moderate-to-vigorous activity (MVPA) levels.

Subjects and methods: The sample comprises 724 Portuguese children (9-11 years). MVPA was assessed with an accelerometer, and body mass index (BMI) was computed. Daily changes in MVPA and their correlates (gender, BMI, and maturity) were modeled with a multilevel approach, and tracking was calculated in two ways: auto-correlations (r) and Foulkes & Davies γ.

Results: 51.3% of boys and 26.2% of girls achieved the 60min/day of MVPA**.** Daily MVPA showed a nonlinear trend with a marked reduction on the weekend. Normal-weight children were more active than obese children and no effect was found for biological maturation. Autocorrelations and tracking are low in both boys (r=0.37; γ =0.59±0.01) and girls (r=0.32; γ =0.56±0.01).

Conclusions: children MVPA levels during a week are highly unstable. Boys are more active than girls, maturation does not affect their MVPA, and obese children are more at risk of not meeting 60 min/day of MVPA. These results highlight the importance of the school setting and environmental opportunities for increasing children daily MVPA.

Keywords: Physical Activity, Children, Accelerometry, Tracking

Introduction

Although there is some controversy about negative trends in children's daily physical activity (PA) over the last decades (Ekelund et al., 2011; Westerterp & Speakman, 2008), it has been recently shown that moderate-to-vigorous PA (MVPA) levels are usually low in children and adolescents (Hallal et al., 2012). Following Strong et al. (2005), the World Health Organization (WHO) established a minimum of 60 minutes of daily MVPA for individuals aged 5-17 years as recommended levels of PA for health benefits (World Health Organization, 2010). This milestone is used worldwide to monitor whether children and youth from distinct populations achieve this healthy goal (Beets et al., 2010; Brusseau et al., 2011).

Using cross-sectional data, Verloigne et al. (2012) described PA levels in 5 European countries (Belgium, Greece, Hungary, the Netherlands and Switzerland), and found that only 4.6% of the girls and 16.8% of the boys complied with the MVPA recommendations of at least 60 minutes/day. On the other hand, Baptista et al. (2012) showed that the prevalence of 10-11 years old Portuguese children meeting the 60 minutes goal was 51.6% in boys and 22.5% in girls. In another study, Basterfield et al. (2011) investigated 2-year changes in PA in English children, and concluded that their overall levels was low [median: 26 minutes of daily MVPA at 7 years of age, and 24 minutes at 9 years of age (both sexes combined)]; further, only 6.4% of the children achieved a mean of 60 minutes of daily MVPA at 7 years and only 5.7% at 9 years of age.

PA change over the week, and children tend to be more active during week days than weekend days (Nilsson et al., 2009). However, few studies have investigated how children's PA changes across the entire week, and if there is a pattern in this change. We were able to identify only one study that investigated daily PA levels and patterns during a whole week in children and adolescents 8 to 12 year of age (Telford et al., 2013). A pattern for pedometer step counts, and accelerometer–derived MVPA and light PA was characterized, in general, by increases in PA on school days (from Monday to Friday), followed by a decrease in PA levels on the weekend. In addition, children were more active on Friday (39% of boys and 21% of girls achieved more than 60 min of MVPA),

and less active on Sunday (16% of boys and 10% of girls achieved more than 60 min of MVPA).

Tracking is frequently used to investigate changes in children's interindividual PA levels, i.e., to describe yearly stability/instability in PA (Jones et al., 2013). It is generally accepted that tracking describes the tendency of an individual to remain in the same relative position within a group over time (Malina, 2001). For example, Dencker et al. (2013) studied PA changes and stability in 10 y old children over two years, and reported that their PA tracking was low-to-moderate, together with an increase in their time spent in sedentary activities. In addition, Edwards et al. (2013) used tracking to investigate PA patterns over a 4 year period (children were 3 years old at baseline), and showed that not only were boys more active than girls, but also they maintained their MVPA levels for longer. Although relevant in terms of short-to-long term behavior stability and changes, these yearly tracking studies do not consider the importance of daily MVPA variation (intraindividual change in interindividual differences) in children's routines during an important and repeated window of their lives – their weekly routines, governed by the school setting where they spend a large portion of their daily awake time.

This study aims (1) to identify daily MVPA trends of 10 year-old children achieving 60 minutes/day; (2) to model MVPA daily fluctuation levels, and estimate the effect of individual characteristics such as gender, body mass index (BMI), and maturity offset using multilevel modeling; (3) and to describe stability in children's daily MVPA using the approach suggested by Foulkes & Davies (1981).

Methods

Sample

The sample comprises 724 Portuguese 5th grade children (396 girls and 328 boys) aged 9-11 years and randomly selected from 23 schools of the Oporto metropolitan area, Portugal. All children are part of the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE), a research project conducted in 12 countries from all major world regions. Briefly, this project aims

to determine the relationship between lifestyle and obesity in a large multi-national study of children, and to investigate the influence of higher order characteristics such as behavioral settings, physical, social and policy environments on the observed relationships within and between countries (Katzmarzyk et al., 2013). All 5th grade children were invited to take part in ISCOLE, but only those aged between 9 and 11 years old were classified as "eligible" to be part at the project. From those children, a sample of approximately 30-40 children per school was randomly selected (50% for each sex). Non-response was negligible and missing information was at random. All children and parents/legal guardians received extensive information regarding the research project; written consent and assent was then obtained from parents/legal guardians and children, respectively. Consents were also obtained from physical education departments, school principals and parental council in each school. The Oporto University Ethics Committee approved the project. Further, all information was collected by certified personnel from the ISCOLE study center under highly controlled conditions as reported elsewhere (Katzmarzyk et al., 2013).

Anthropometry

Height was measured using a Seca 213 portable stadiometer (Hamburg, Germany), with the head positioned to the Frankfurt plane. Body mass was measured with children in light clothing with a portable Tanita SC-240 body composition analyzer (Helligton Heights, USA), which gives reliable and valid information (Barreira et al., 2013). All procedures were previously described by Katzmarzyk et al. (2013). BMI was computed using the standard formula BMI = [body mass (kg)/height (m)^2], and all children were classified as normal weight, overweight and obese according to the cut points defined by the WHO (World Health Organization, 1995).

Maturity offset

Biological maturation was indirectly estimated with the maturity offset procedure proposed by Mirwald et al. (2002). This procedure estimates the

timing of occurrence of peak height velocity (PHV). The maturity offset estimates the distance each subject is from PHV using chronological age and the value is expressed in decimal years. A positive (+) maturity offset represents the number of years the participant is beyond PHV, whereas a negative (–) maturity offset represents the number of years the subject is before PHV.

Physical activity

PA was objectively assessed with the Actigraph GT3X+ accelerometer (ActiGraph LLC, Pensacola, FL, USA) during 24 hours/day for seven consecutive days, including 2 weekend days, being only removed during water activities (i.e., showering, swimming). The accelerometer was attached to the participant using an elastic belt worn around the waist with an adjustable clip. The accelerometer unit was placed in line with the mid-axillary line and lying on the iliac crest (i.e., hip location). The minimal amount of accelerometer data that was considered acceptable was 4 days with at least 10 hours of wear time per day, including at least one weekend day; 724 Children fulfilled this condition.

PA variables were derived using activity counts as advocated by Evenson et al. (2008). For the purposes of this study, only time (expressed in minutes) spent in MVPA was used, in each of the seven days (Monday to Sunday). MVPA was defined as greater than 574 activity counts per 15 seconds.

Data analysis

Descriptive statistics were computed in SPSS 20. Given the highly positive skewed daily MVPA distribution, a square root transformation was used (Sqrt_MVPA) as previously done by Telford et al. (2013) with similar data distributions.

Stability (i.e., tracking) of daily MVPA was approached in two ways: (i) the classical method by use of auto-correlations (r), and (ii) the approach developed by Foulkes & Davies (1981). Since with 7 days we will have a 7-by-7 auto-correlation matrix with 21 correlations, the mean correlation across the seven days was computed using the Fisher z-transformation as implemented in STATA 13. The Malina's (1996) subjective cut-points was used to interpret the

magnitude of auto-correlations, if r≤0.30 tracking is low, if 0.30<r≤0.60 it is considered moderate, and if r>0.60 tracking is reasonably good. The Foulkes & Davies γ (1981) statistic was also used to estimate MVPA tracking as implemented in the Timepath software (1988). As an index of tracking, r is perfect (r =1) when a group of individual growth profiles do not intersect, that is when the relative ranking within the response distribution (MVPA) is maintained over time (in our case, over the seven days). On the contrary, no tracking occurs if γ≤0.5; if γ is greater than 0.5, tracking is said to occur. The γ statistic was computed separately for boys and girls. Using a procedure implemented in Timepath software (Rogosa, 1994; Rogosa, 1984; Rogosa & G.A., 1988) was used in two steps. First, to describe the consistency of MVPA across the seven days, a point estimate of an individual version of formulated by Rogosa (1984) as a measure of individual tracking was used. Since γ was obtained for all participants, the 5^{th} percentile (P5), first quartile (Q1), median (Me), third quartile (Q3), and 95^{th} percentile (P95) of each individual γ were calculated. Secondly, a global γ was estimated to describe children MVPA tracking across the seven days for all subjects.

Daily changes in MVPA and their time-invariant correlates (gender, BMI categories, and maturity offset) were modeled within HLM 7 software (Rogosa & Saner, 1995) using maximum likelihood estimation techniques. This was done with a two-step approach. Firstly, to fit the intricacy of daily changes in MVPA, we used a polynomial function of time with increased complexity. Guided by HLM visual graphic capabilities we fitted a series of nested polynomial models till a 3^{rd} degree. Final decisions about the best fitting solution were made according to Deviance and corresponding chi-square changes in nested models of increasing complexity. A more complex model fits better than a previous one if the differences in their respective Deviances are statistically significant. This is done by a Chi-square test with degrees of freedom equal to the difference in estimated parameters of both models. Secondly, we introduced the time-invariant correlates [gender, BMI categories (normal weight as the reference group, overweight and obese), and maturity offset], and all parameters were simultaneously estimated and tested for their significance.

Results

On average, boys and girls have similar ($p>0.05$) height, weight and BMI; however, as expected, girls are closer ($p<0.001$) to their age at PHV than boys (Table I).

Table I - Boys and girls basic descriptive statistics (means ± standard deviations, t and p-values)

	Boys M±SD	Girls M±SD	t	p-value
Height (cm)	143.49 ± 6.43	143.47 ± 7.08	-0.04	0.971
Weight (kg)	40.51 ± 9.23	40.24 ± 9.25	-0.39	0.698
BMI ($kg \cdot m^{-2}$)	19.53 ± 3.45	19.38 ± 3.39	-0.58	0.562
Maturity offset	-2.75 ± 0.49	-1.24 ± 0.62	34.79	<0.001

Table II shows medians (Me) and interquartile range (IQR) and means (M) and standard deviation (SD) of time spent in MVPA, as well as the prevalence of boys and girls reaching daily recommended 60 minutes of MVPA for each of the days. On average, boys have higher MVPA than girls. Further, during the week days, time spent in MVPA ranges from 44 to 72 minutes and 33 to 55 minutes in boys and girls, respectively. During the weekend, a pronounced decrease in MVPA occurs. The percentage of boys and girls meeting daily MVPA 60 minutes recommendations is moderate. Values are higher during the week and lower on the weekend.

Table II - Descriptive statistics for boys and girls daily MVPA

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Boys							
Me (IQR);	65.75 (47.25)	64.50 (47.75)	67.00 (44.00)	68.75 (51.38)	68.25 (45.75)	*49.75 (50.63)*	*36.25 (42.00)*
M (SD)	*67.87 (35.72)*	*68.65 (38.24)*	*70.01 (35.88)*	*72.45 (36.40)*	*72.32 (35.59)*	*59.44 (39.40)*	*44.25 (34.47)*
Girls							
Me (IQR);	47.50 (30.88)	46.25 (33.00)	46.00 (29.25)	*43.75 (34.00*	53.00 (29.63)	*34.75 (29.38)*	27.50 (26.50)
M (SD)	*49.27 (25.30)*	*48.23 (25.37)*	*48.18 (22.89)*	*48.35 (24.33)*	*55.08 (26.26)*	*39.61 (24.41)*	*33.91 (25.99)*
%Rb	58.0%	56.7%	58.4%	58.4%	59.0%	41.6%	26.9%
%Rg	28.6%	28.1%	27.6%	28.9%	36.5%	18.6%	15.0%

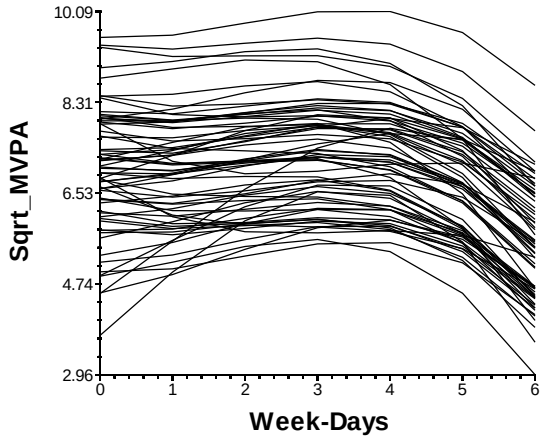
Me (IQR)**:** Median and interquartile range; *M (SD): Means and standard deviations*; %Rb: Percentage of boys reaching daily recommended 60 minutes of MVPA; %Rg: Percentage of girls reaching daily recommended 60 minutes of MVPA.

Daily modeling results of Sqrt_MVPA are shown in Table III, which presents the best fitting polynomial model (Model 1: 3rd degree) and Model 2 with a set of covariates: gender, BMI categories, and maturity off-set. The 3rd degree polynomial shows a nonlinear trend in MVPA, with a clear declining trend starting on Friday and reaching the lowest values on Sunday (but see Figures 1 and 2). As expected, boys have, on average, more daily minutes of Sqrt_MVPA than girls (γ=1.23±0.23, p<0.001) and obese children spent less daily Sqrt_MVPA minutes than normal weight (γ=-0.53±0.14, p<0.001). No significant effects were noticed for biological maturation on Sqrt_MVPA.

Table III – Parameter estimates ± standard errors and p-values of the two best fitting models

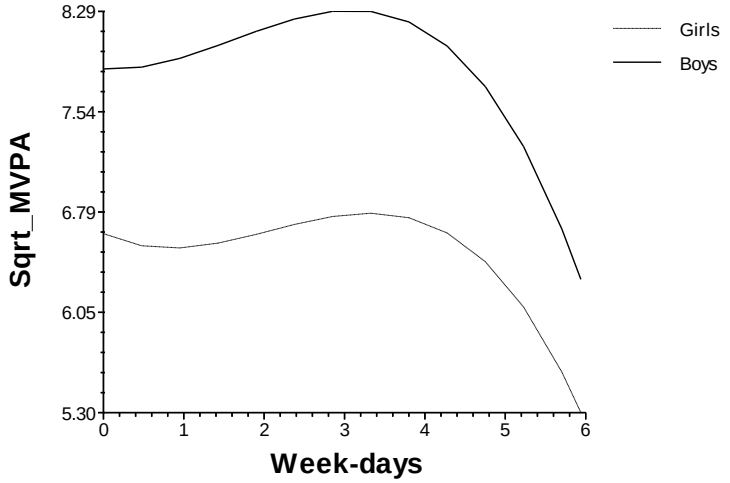
	Model 1	Model 2
Fixed effects		
Intercept	7.18±0.09, p<0.001	6.04±0.18, p<0.001
Gender		1.23±0.23, p<0.001
Overweight		-0.11±0.15, p=0.457
Obese		-0.53±0.14, p<0.001
Maturity offset		0.09±0.09, p=0.366
Linear	-0.18±0.11, p<0.121	-0.28±0.12, p<0.016
Gender		0.24±0.19, p=0.045
Quadratic	0.19±0.05, p<0.001	0.21±0.05, p<0.001
Gender		-0.05±0.02, p=0.013
Cubic	-0.03±0.004, p<0.001	-0.04±0.004, p<0.001
Variance components		
Intercept	2.585±0.302, p<0.001	2.331±0.288, p<0.001
Linear	0.394±0.127, p<0.001	0.480±0.127, p<0.001
Quadratic	0.012±0.003, p<0.001	0.011±0.003, p<0.001
Residual	3.603±0.098	3.604±0.099
Deviance	20523.29	20383.93
Nº of estimated parameters	11	17

Figure 1 – Graphical representation of the 3th degree polynomial of daily MVPA (Square root transformed: SQRT_MVPA) in a random sample of children



(0=Monday, 1=Tuesday, 2=Wednesday, 3=Thursday, 4=Friday, 5=Saturday, 6=Sunday)

Figure 2 – 3rd degree polynomial trends in MVPA (square root transformed: Sqrt_MVPA) as a function of gender



(0=Monday, 1=Tuesday, 2=Wednesday, 3=Thursday, 4=Friday, 5=Saturday, 6=Sunday)

The classical auto-correlation approach (mean of all 21 correlations) to describe tracking showed the following low values: boys=0.37, girls=0.32. As for the Foulkes & Davies γ distributional values in boys' and girls' weekly Sqrt_MVPA (Table IV) and since $\gamma \geq 0.5$ provides evidence of tracking, about 50% of boys and girls do show stability in their daily Sqrt_MVPA levels. Boys seem to be more stable, i.e., their γ values are always higher. Population γ estimates

(interindividual differences in MVPA consistency across the all week) showed low to no tracking (girls: γ= 0.56± 0.01; boys γ= 0.59± 0.01).

Table IV - Girls' and boys' tracking (Foulkes & Davies γ) descriptive information for sqrt_MVPA

	Sqrt MVPA	
	Girls	Boys
Min	0.04	0.04
P5	0.25	0.25
Q1	0,48	0.51
Med	0.55	0.60
Q3	0.67	0.69
P95	0.85	0.87
Max	0.99	0.99

(Min=minimum, P5=percentile 5, Q1=1st quartile, Med=median, Q3= 3rd quartile, P95=percentile 95, Max=maximum)

Discussion

The present study aimed to (1) identify the frequency of 9-11 y old Portuguese children meeting daily recommended 60 minutes of MVPA over a week; (2) to model daily changes in MVPA using gender, BMI categories and maturity offset as covariates; and (3) to estimate MVPA daily tracking using auto-correlations, and Foulkes & Davies γ. Results showed that, on average, boys spend more time in daily MVPA than girls (between 26.9%-59% and 15%-36.5%, respectively), regardless of the day. A previous report with 10-11y old Portuguese children using a different cut-off to define MVPA indicated that during the seven days, 51.6% of the boys and 22.5% of the girls met the WHO recommendations (Baptista et al., 2012). Similarly, in a sample of primary school children aged 5-10 y old from southwest Germany, it was found that 68 % of the boys and 28 % of the girls met the recommendations (Kettner et al., 2013). However, a study conducted with 10-12 y old children from 5 European

countries (Verloigne et al, 2012) showed that only 16.8% of the boys and 4.6% of the girls met the recommendations. Further, Swiss children were found to have the higher values of MVPA recommendations, whereas Greek children presented the lowest MVPA values. When comparing these five countries results with the present report, Portuguese boys and girls are more active. It has to be recognized that the different cutoffs used in these studies may explain, to some extent, some discrepancies, a well-known fact in the literature (Trost et al., 2011).

In the present study ≈60% of the boys and ≈30% of the girls met the daily MVPA guidelines during the week, whereas, during the weekend these values decrease to 41.6% and 18.6% on Saturday, and to 26.9% and 15% on Sunday, respectively. These results highlight clear sex differences in daily MVPA levels, as boys are systematically more active than girls. This follows the expected trend as boys have been generally found to be more active due to biological factors (Maia et al., 2002), but may also be attributable to parental, social and environmental factors (Crespo et al., 2013), which imply more time engaging in sports and free-living activities. Furthermore, boys typically view school break as a chance to engage in competitive games that tend to dominate play spaces in the school yard while girls view the school break period as a time for socializing (Stanley et al., 2012), i.e., the majority of boys manifest competency by being active players in sports games and the majority of girls walk and talk (Boyle et al., 2003). On the other hand, throughout the after-school period, there is some suggestion that parents perceive the neighborhood to be safer for adolescent boys compared to adolescent girls (Carver et al., 2008).

In Australian children followed longitudinally from 8 to 12 years, boys were more active than girls, and PA also declined on the weekends (Telford et al., 2013). In addition, the percentage of Australian children achieving WHO PA guidelines was lower than in Portuguese children, ranging from 30% to 40% in boys on weekdays, and below 22% on weekends. In girls, this percentage was always under 20%. These differences between Portuguese and Australian children may be due to different sports policies implemented in the school settings. For example, within the Portuguese school system all children have at

least two days of physical education (PE) classes per week, which represents 135 minutes of structured activity, and have the opportunity to freely practice sports in clubs settings outside the classroom with a varied range of forms available (Football, Basketball, Badminton, Tennis, Swimming, Gymnastic, etc.). In Australia, 120 minutes per week of PE is mandated in most states, however, not all schools actually schedule 120 minutes. Out of school hours sport is sometimes offered by schools, but more commonly by non-school-based clubs.

Multilevel modeling results indicated a nonlinear trend in MVPA levels with a very modest increase during schooldays and a rapid decline from Friday to Sunday. Although boys and girls have similar weekly MVPA patterns, boys spend more time in MVPA than girls, regardless of the day. Telford et al. (2013) also investigated MVPA patterns over a week and concluded that the time spent in MVPA was 7.7 min/day and 7.3 min/day higher on Friday when compared to Monday for boys and girls, respectively; further, boys spent 26.0 min/day and girls 16.9 min/day less time in MVPA on Sunday as compared to Friday. Portuguese boys expended 2.5 min/day less on Monday as compared to Friday and 32 min/day on Sunday as compared to Friday; on the contrary, girls expend less 5.5 min/day and 25.5 min/day on Monday and Sunday when compared to Friday. These differences between weekday MVPA and weekend MVPA have been attributed to the longer time children spend in sedentary behaviors (e.g., more screen time) (Durant et al., 1996; Sandercock et al., 2012; Taverno Ross et al., 2013). It is also possible that these differences may be related to peer and family support to PA (Corder et al., 2013; McMinn et al., 2013).

Gender and BMI were found to have significant effects on MVPA levels. As previously stated, boys spend more time in daily MVPA than girls; further, as expected, obese children are less active than normal weight children, but no MVPA differences between overweight and normal weight children were found, which is consistent with previous findings in preschool-age children (Niederer et al., 2012)**.** It is possible that higher self-efficacy of normal weight/overweight children as compared to obese children may explain this issue. It has been reported that obese children have a diminished notion of their body capabilities which are linked to lower motor coordination and skill development and

consequent MVPA levels (D'Hondt et al., 2009; D'Hondt et al., 2013; Trost et al., 2001). Thus, this group of children should be followed with particular care since they tend to be less active during adolescence and have higher probability of developing cardiometabolic diseases (Brouwer et al., 2013).

Biological maturation had no significant effect on MVPA levels across the week in this study. Wickel et al. (2009) compared PA levels among early, average, and late maturing boys and girls, and after controlling for chronological age, found no significant differences in PA levels of the three groups (Wickel et al., 2009). On the contrary, Thompson et al., (2003) using data from a seven year longitudinal study, showed that PA decreased with increasing biological age, with more mature children being less physically active. In addition, since girls mature earlier than boys, this might explain some of the observed difference between genders. Although in our data there was a significant mean difference in maturity offset favoring girls (see Table I), maturity was not a significant PA predictor which may be related to the narrow age range of the sample (9 to 11 years), in which only some girls are prepubescent.

One of the novelties of the present study is the use of tracking to understand how stable children's daily MVPA patterns are over a week. Similar approaches have been used to understand interindividual differences in intraindividual PA changes, but only between consecutive years or over several years (Dencker et al., 2013; Kristensen et al., 2008). These studies indicate that children's and adolescents PA levels have low to moderate tracking (Dencker et al., 2013; Kristensen et al., 2008). However, we were not able to identify any study that investigated heterogeneity in MVPA levels over a week in children, as this time frame is universally used with accelerometry data. The main finding in our data is that only 5% of children showed high tracking (boys γ=0.85; girls γ=0.87), i.e., were systematically stable in their MVPA trajectories over a week. This is somewhat surprising and should not be confused with results from Tables II and III. In fact, a child may reach the cut-point of 60 minutes a day of MVPA, but his/her results across the week may fluctuate in some random fashion, governed by school activities and/or leisure activities outside the school. Further analysis using latent trajectories or latent classes

should be used to identify different groups of children and potential covariates that may condition their belonging to low and high tracking groups in order to improve the efficacy of intervention programmes.

Conclusions

In conclusion, the results of this study provide further support to the known influence of gender and weight categories in children's MVPA. Daily MVPA has a nonlinear trend with a marked decrease during the weekend. Explicitly, girls and obese children spend fewer minutes per day in MVPA. Further, maturation does not affect 10 year-old children's MPVA although girls are, on average, at the take-off of their growth spurt. A strong instability in MVPA levels was observed over a week. This set of results raises new questions about the importance of school settings and household effects on children's MVPA.

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Declaration of interest

The authors report no declarations of interest.

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Capítulo 3

Profiling children physical activity, diet, screen and sleep habits in Portuguese Children

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Abstract

This study aims (1) to describe the profile configurations of children risk behaviors; (2) to identify the number of risk behavior patterns classes; and (3) to estimate the joint effects of individual and socio-demographic characteristics in predicting risk class membership. The sample comprises 686 Portuguese children (9-11 years). Physical activity was monitored with accelerometry and sleep time estimated from daily data. Nutritional habits, screen time and sociodemographic characteristics were obtained. Height, weight, waist circumference, percent body fat, body mass index and maturity offset were measured and estimated. Risk behaviors descriptive configurations were explored with Configural Frequency Analysis. Latent classes were obtained, and logistic regression was used to predict the class membership. A high percentage of children combine risk behaviors to their health; children have distinct profiles of risk behaviors which are influenced by sex, weight status, Maternal education and household income, that should be taken into consideration when developing more efficient intervention programs.

Keywords: risk behaviors, latent classes, youth, ISCOLE

Introduction

Unhealthy behaviors, such as low physical activity (PA) levels, high screen time, poor diet, and reduced sleep time, have been associated with cardiovascular diseases, obesity, diabetes and other poor health outcomes, both in adults and in children (Saunders et al., 2014; Thorp et al., 2011; Tremblay et al., 2011). These associations have mostly been studied in bivariate terms (Boeing et al., 2012; Milton et al., 2014; Saunders et al., 2014). For example, Carson et al. (2014) found no association between sedentary time and BMI z-score in Canadian children, whereas moderate-to-vigorous PA (MVPA) was consistently associated with BMI z-score. Further, Kell et al. (2014) concluded that increased consumption of added sugars may be associated with adverse cardiovascular health factors, specially elevated diastolic blood pressure and triglycerides in a multiethnic pediatric sample aged 7-12 years.

In recent years a call has been made to study not only interactions among these unhealthy behaviors and health risks but also to identify behavioral configurations using the concept of clustering or group risk profiling/patterning (Leech et al., 2014). This clustering approach is important because available research highlights that the prevalence of children meeting PA recommendations is low (Brusseau et al., 2013). For example, Arbour-Nicitopoulos et al. (2012) reported that among Canadian youth, only 44% met the recommendations for PA, 26.8% and 25.5% for fruits and vegetables consumption, respectively, and 37.8% watch television for less than 2 h/day. Likewise, Tovar et al. (2012) examined Californian children aged 6 and 11 years particularly with regards to their sleep time, screen time and consumption of sugary drinks and found that only 30.5% of children sleep more than 10 hours per night, 35.3% met the recommendations of screen time, and only 2% of children consumed no sugary drinks on a daily basis.

Using a cluster analysis approach, Fernández-Alvira et al. (2013) used data from seven European countries, and identified five distinct clustered groups based on sugary drink consumption, PA levels, screen time, and sleep duration. Similarly, Jago et al. (2010) aimed to identify children's risk behavior clusters

(PA and sedentary time), and found that three groups emerged from their analysis. Patterns/profiles of healthy behaviors (based on sleep duration, PA, screen time and diet) were also studied in Australian children by Magee et al. (2013), whom identified three behavioral profiles: the first (27.7%) was termed "healthy"; the second profile (24.8%) was labeled "sedentary" because higher rates of physical inactivity and screen time were found; the third profile (47.5%) was named "short sleepers/unhealthy eaters" because children tended to consume high fat, sugary foods and drinks and had the highest percentage of children with less than 10 h/night of sleep time. When comparing the healthy profile with the other two (sedentary profile and short sleepers/unhealthy eaters) the latter two groups had elevated odds for obesity at 2-years of follow-up. These examples show the importance of considering risk factor clustering in terms of public health, education, and prevention because it will foster a better understanding about which set of joint behaviors need to be simultaneously changed in order to improve children's health. However, in a recent review, Leech et al. (2014) reported some inconsistency in relation to the cumulative effect of these behaviors on obesity given that while some studies found higher prevalence of overweight/obesity in unhealthy clusters, others researches found no association at all. Further research in this area is clearly needed.

As the identification and understanding of risk behavior patterns in children is still in its early days, we explored these issues in a sample of Portuguese children. We aimed to (1) describe profile configurations of risk behaviors; (2) use latent class analysis to identify, based on maximum likelihood estimation techniques, the number of risk behavior pattern classes, and (3) to estimate the joint effects of individual and socio-demographic characteristics in predicting risk class membership.

Material and Methods

Design and participants

Data for the present paper is from the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE), a research project conducted in 12

countries from all major world regions. Details of the overall study design have been previously reported by Katzmarzyk et al. (2013), and by Pereira et al. (Unpublished - under review) regarding the Portuguese site. Briefly, the sample for the present study comprises 686 Portuguese 5th grade children (381 girls and 305 boys), aged 9-11 years which were randomly selected from 23 schools of the Oporto metropolitan area, in northern Portugal.

Detailed information about the study was sent to all parents, and written consent was obtained from the parents as well as assent to participate from the children. The Oporto University Ethics Committee approved the project. Further, all data was collected by certified personnel from the ISCOLE study center under highly controlled conditions as reported elsewhere (Katzmarzyk et al., 2013).

Anthropometry

Height was measured using a Seca 213 portable stadiometer (Hamburg, Germany), with the head positioned to the Frankfurt plane. Weight, body mass and percentage of body fat were measured with children in light clothing, using a portable Tanita SC-240 body composition analyzer (Hellington Heights, USA), which gives reliable and valid information (Barreira et al., 2013a). Waist circumference was measured at the end of gentle expiration with a non-elastic tape held midway between the lower rib margin and the iliac crest (Katzmarzyk et al., 2013). Body mass index (BMI) was computed using the standard formula [body mass (kg)/height (m)^2], and children were categorized as normal weight and overweight/obese according to cut points defined by the World Health Organization (WHO, 1995). All measurements were made by trained researchers in a standardized way (Katzmarzyk et al., 2013).

Maturity offset

Biological maturation was indirectly estimated with the maturity offset procedure proposed by Mirwald et al. (2002). The maturity offset estimates the distance each subject is from peak height velocity (PHV) using chronological age and the value is expressed in decimal years. A positive (+) maturity offset represents the

number of years the participant is beyond PHV, whereas a negative (–) maturity offset represents the number of years the subject is before PHV.

Physical activity and sleep time

PA and sleep time were objectively assessed with the Actigraph GT3X+ accelerometer (ActiGraph LLC, Pensacola, FL, USA), for 24 h/day on seven consecutive days (including 2 weekend days), being only removed during water activities (i.e., showering, swimming). The accelerometer was attached to the participant using an elastic belt worn around the waist with an adjustable clip. The accelerometer unit was placed in line with the mid-axillary line and lying on the iliac crest (i.e., hip location). The minimal amount of accelerometer data that was considered acceptable was 4 days with at least 10 hours of wear time per day, including at least one weekend day; all 686 children fulfilled this condition.

PA variables were derived using activity counts as advocated by Evenson et al. (2008). For the purposes of this study, only the average weekly time (expressed in minutes) spent in MVPA was used, and was defined as greater than 574 activity counts per 15 seconds (Evenson et al., 2008). Children were categorized in two groups (<60 $min \cdot d^{-1}$; ≥60 $min \cdot d^{-1}$) according to their compliance with MVPA daily recommendations (World Health Organization, 2010). The average daily MVPA minutes across the seven days was used.

Sleep time was estimated as proposed by Tudor-Locke et al. (2014) and refined by Barreira et al. (under review). Sleep time was also estimated from average week time (expressed in hours) and children were categorized into two groups (<10 $h \cdot night^{-1}$; ≥10 $h \cdot night^{-1}$), according to compliance, or not, of the daily recommendation for sleep time proposed by the National Sleep Foundation (2013).

Fruits, vegetables and sugary drinks consumption

The information related to fruit, vegetable and sugary drink consumption was obtained from a food frequency questionnaire (FFQ) integrated into a diet and lifestyle questionnaire (Katzmarzyk et al., 2013). Children were asked about

several different types of food consumed in a usual week. The FFQ lists 23 food categories and has examples of individual food items, but no portion sizes. For fruit/vegetable consumption, childrens responses were divided in two groups - those consuming this type of food every day of the week and those who did not (the former was considered as a behavior risk group); as for sugary drink consumption, children were also divided in two groups according to their median responses – those who consumed less than 2 times per week and those who consumed two or more times (the latter was considered the risk behavior group).

Sedentary Behavior

Information regarding sedentary behavior was derived from recreational TV watching obtained from the diet and lifestyle questionnaire (Katzmarzyk et al., 2013), and categorized according to screen time recommendations for children (< 120 min·d^{-1}; ≥ 120 min·d^{-1}) (Davis et al., 2007).

Socio-demographic characteristics

A demographic and family health history questionnaire comprising socio-demographic information about the household, such as maternal education and household income (Katzmarzyk et al., 2013), was completed by parents. Maternal education and household income were divided into categories as follows: for maternal education level, three categories were created (<Grade 12; Grade 12/diploma for technical qualification; and University level). Similarly for annual household income we categorized into three groups (<12.000€; between 12.000 € and 29.999€; and ≥ 30.000€).

Statistical analysis

Basic statistics were computed in SPSS 20. All five behaviors were coded as 0 (risk not present, meaning MVPA ≥ 60 min/day, screen time < 120 min/day, fruits and vegetables consumption all days, sleep ≥10 h·night^{-1}, sugary drinks < 2 day·week^{-1}) or 1 (risk present). To describe risk behavior patterns, an exploratory Configural Frequency Analysis (CFA) was performed (von Eye,

2002; von Eye et al., 2010) as implemented in CFA software (von Eye, 2007). A base model called Configural Cluster Analysis, which assumes that all configurations (2^5=32 possible configurations) have the same probability, i.e., the same expected frequency, was used as previously advocated (Schrepp, 2006).

Using M*plus* v. 6 iterative maximum likelihood estimation techniques, a Latent Class Analysis was performed to identify the number of unobserved subgroups comprising individuals of similar behavioral risk. Latent Class Analysis focusing on grouping respondents, or case based on patterns of item (behaviors) responses, is considered a person-centered approach (Bergman et al., 2003; Geiser, 2013). As previously advocated (Collins & Lanza, 2010; Geiser, 2013; Wang & Wang, 2012), model fitting assessment and model comparisons were done using the Pearson r statistic, as a measure of absolute fit, and the bootstrap likelihood ratio difference test, the Lo-Mendell-Rubin adjusted LRT test, the Akaike Information Criteria (AIC), and the Bayesian AIC version (BIC) as measures of relative fit when comparing different number of latent class models. Model comparison was established the following way: firstly a most parsimonious model with only 1 class was fitted; then successive models with an increase in the number of classes, up to 4 were estimated. To avoid identification problems related to local maxima, the algorithm iterations were set as advocated by Wang and Wang (2012) and Geiser (2013). The best fitting model is the one with lower values of relative fit measures, and has a substantive interpretation. Using the new classification classes, we then used logistic regression to predict children class membership having sex, BMI, maturity offset, mothers education and household income as predictors. This analysis was done in SPSS 20.

Results

Table 1 displays descriptive statistics regarding the sample characteristics. On average, children were 143.44 cm tall, weighed 40.4 Kg, had 22.9% of body fat, a BMI of 19.5 $Kg \cdot m^{-2}$ and were 1.90 yrs way from age at PHV. Further, 15.7%

of children's mothers had a University degree, and 39.4% of children's families presented a low household income (less than 12.000€ per year).

Table 1: Sample descriptive characteristics

	Total n (%) or mean ± sd
Anthropometric sample characteristics	
Height (cm)	143.47 ± 6.8
Weight (kg)	40.39 ± 9.2
Waist circumference (cm)	66.32 ± 8.7
Percent body fat (%)	22.92 ± 7.5
BMI ($Kg \cdot m^{-2}$)	19.47 ± 3.4
Maturity offset	-1.90 ± 0.9
Gender	305 (44.5%)
Boys	381 (55.5%)
Girls	
Weight Status	
Normal weight	372 (54.2%)
Overweight/obese	314 (45.8%)
Maternal education	
< Grade 12	317 (46.2%)
Grade 12/diploma/technical qualification	191 (27.8%)
University	108 (15.7%)
Did not report	70 (10.3 %)
Household income	
<12.000 €	270 (39.4%)
12.000 € - 29.999 €	195 (28.4%)
≥ 30.000 €	76 (11.1%)
Did not report	145 (21.1%)

When considering individual risk behaviors, only 36.4% of the children met the PA recommendation of at least 60 $m \cdot d^{-1}$ of daily MVPA. Moreover, 36.6% spent less than 2 h/day over the week in screen time, 28.7% eat fruits/vegetables

daily, 64.7% consumed sugary drinks less than two days/week, and only 7.3% slept at least 10 h/night.

Table 2 contains descriptive information regarding the Configural Cluster Analysis base model with its 32 possible configurations. There is a wide variation in configurations whatever the joint risk factors considered, from only 1 cases (≈0.2%) with no risk to 67 cases (≈10%) with all five risk behaviors. Further, the frequency of three or more risk behaviors is 533 cases (78%)

Table 2: Configurations of behavioral risks, their observed (fo) and expected frequencies (fe), χ^2 statistic and p-values

Nº of risks	MVPA < 60 min	Fruits/Vegs <7 days	Sleep < 10h	Screen ≥ 120 min	Sugar Drinks ≥ 2 days/week	fo	fe	χ^2	p-value
0	0	0	0	0	0	1	21.438	19.484	<0.001
1	0	0	0	0	1	2	21.438	17.624	<0.001
1	0	0	0	1	0	2	21.438	17.624	<0.001
1	0	0	1	0	0	19	21.438	0.277	0.598
1	0	1	0	0	0	1	21.438	19.484	<0.001
1	1	0	0	0	0	2	21.438	17.624	<0.001
2	0	0	0	1	1	2	21.438	17.624	<0.001
2	0	0	1	0	1	11	21.438	5.081	0.024
2	0	0	1	1	0	18	21.438	0.551	0.457
2	0	1	0	0	1	3	21.438	15.857	<0.001
2	0	1	0	1	0	3	21.438	15.857	<0.001
2	0	1	1	0	0	38	21.483	12.796	<0.001
2	1	0	0	0	1	0	21.483	21.483	<0.001
2	1	0	0	1	0	3	21.483	15.857	<0.001
2	1	0	1	0	0	43	21.483	21.688	<0.001
2	1	1	0	0	0	5	21.483	12.604	<0.001
3	0	0	1	1	1	14	21.438	2.580	0.108
3	0	1	0	1	1	3	21.438	15.857	<0.001
3	0	1	1	0	1	25	21.438	0.592	0.442
3	0	1	1	1	0	52	21.438	43.572	<0.001
3	1	0	0	1	1	3	21.438	15.857	<0.001
3	1	0	1	0	1	4	21.438	14.184	<0.001
3	1	0	1	1	0	56	21.438	55.723	<0.001
3	1	1	0	0	1	1	21.438	19.484	<0.001
3	1	1	0	1	0	9	21.438	7.216	0.007
3	1	1	1	0	0	72	21.438	119.257	<0.001
4	0	1	1	1	1	56	21.438	55.723	<0.001
4	1	0	1	1	1	17	21.438	0.916	0.338
4	1	1	0	1	1	10	21.438	6.102	0.014
4	1	1	1	0	1	24	21.438	0.306	0.580
4	1	1	1	1	0	120	21.438	453.158	<0.001
5	1	1	1	1	1	67	21.438	96.837	<0.001

0= no; 1= yes; Example: 00000 = 0 risk behaviors; 11111 = 5 risk behavior

Table 3 displays information regarding the test criteria to find the best number of latent classes. The most parsimonious model with only a single class was rejected, favoring a two classes model. Further, there was no statistical justification to go beyond a 2-latent class model based on the best fit measures (lower relative fit and more parsimonious model given also the number of free parameters). Figure 1 illustrates the maximum likelihood solution to display the conditional probabilities of the 2-classes model (for details, see Wang and Wang (2012)). Given the probabilities of behavioral risk, we labeled class 1 as "active, sedentary behaviors and poor eaters"; class 2 was labeled as "inactive, but good eaters".

Table 3: Criteria used to identify the best number of latent classes

Models	Nº of parameters	Absolute fit Measure	Relative fit measures			
		Pearson r (p-value)	BLR	L-M-R LRT	AIC	BIC
1 class	5	59.711 (p=0.0002)	-	-	3882.392	3905.046
2 classes	11	18.208 (p=0.5737)	-1936.196	42.152, p<0.0001	3851.165	3901.004
3 classes	17	8.997 (p=0.8312)	-1914.582	8.873, p=0.5295	3854.065	3931.090
4 classes	23	4.064 (p=0.8513)	-1910.033	5.333, p=0.1575	3860.596	3964.806

-, not applicable; BLR, Bootstrap likelihood ratio test; L-M-R LRT, Lo-Mendell-Rubin likelihood ratio test; AIC, Akaike information criteria; BIC, Bayesian AIC.

Figure 1: Profiles for the 2-class LCA model of risk behaviors

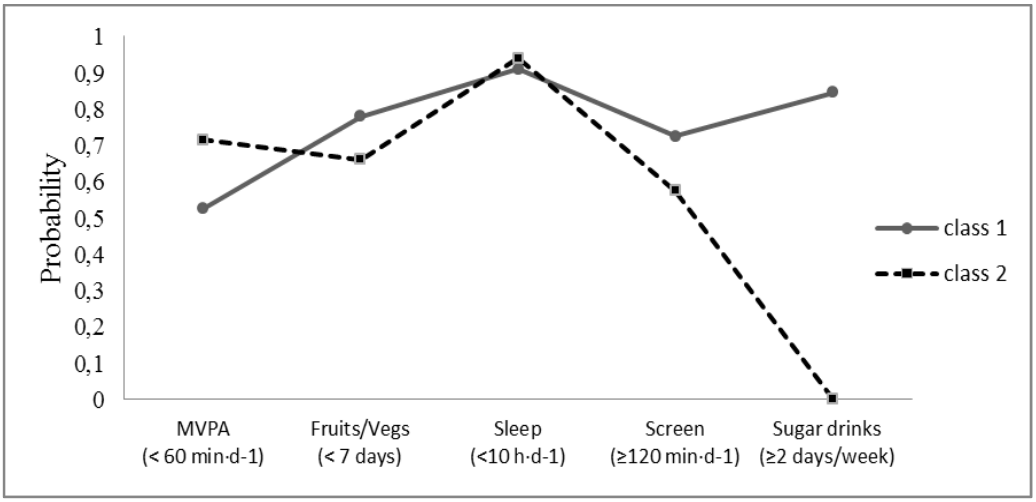

Table 4: Behavior, biological and demographic characteristics of the Portuguese 2- latent classes

	Class 1 (n=242) Active, sedentary behaviors and poor eaters n (%)	Class 2 (n=444) Inactive, good eaters n (%)	p-value
MVPA			<0.001
≥ 60 min.d-1	116 (47.9%)	134 (30.2%)	
< 60 min.d-1	126 (52.1%	310 (69.8%)	
Fruits/Vegetables			0.004
All days	53 (21.9%)	144 (32.4%)	
< 7 days	189 (78.1%)	300 (67.6%)	
Sleep time			0.051
≥ 10 h.d-1	24 (9.9%)	26 (5.9%)	
< 10 h.d-1	218 (90.1%)	418 (94.1%)	
Screen time			0.002
<120 min.d-1	70 (28.9%)	181 (40.8%)	
≥ 120 min.d-1	172 (71.1%)	263 (59.2%)	
Sugar drinks			<0.001
< 2 days/week	0 (0.0%)	444 (100.0%)	
≥ 2 days/week	242 (100.0%)	0 (0.0%)	
Gender			0.005
Girls	117 (48.3%)	264 (59.5%)	
Boys	125 (51.7%)	180 (40.5%)	
Weight status			0.059
Normal Weight	143 (59.1%)	229 (51.6%)	
Overweight/obese	99 (40.9%)	215 (48.4%)	
Maternal education			<0.001
< Grade 12	120 (49.6%)	197 (44.4%)	
Grade 12/diploma/technical qualification	79 (32.6%)	112 (25.2%)	
University	20 (8.3%)	88 (19.8%)	
Did not report	23 (9.5%)	47 (10.6%)	
Household income			0.106
<12.000 €	94 (38.8%)	176 (39.6%)	
12.000 € - 29.999 €	77 (31.8%)	118 (26.6%)	
≥ 30.000 €	18 (7.4%)	58 (13.1%)	
Did not report	53 (21.9%)	92 (20.7%)	
Maturity offset	Mean±SD -2.02±0.95	Mean±SD -1.83±0.85	0.292

Table 4 displays frequencies of behaviors, biological and demographic characteristics of the two latent classes, as well as their individual differences based on a qui-square test. Class 1 was significantly (p≤0.05) more active, slept more, but drank more sugary drinks, eat less fruits/vegetables and had increased screen time. Further, gender frequency was significantly different (p=0.004) between groups, with more girls being classified in class 2, while more boys were categorized in class 1; but no between group significant differences were observed regarding to weight status (p=0.059). Significant differences were observed in maternal education, as a higher prevalence of mother with a University degree was found in Class 1; however, no significant difference was found, among groups, in household income distribution (p=0.106).

Table 5 shows the results of the logistic regression. Sex, weight status and maternal education level were significant predictors of latent classes. So, boys are less likely to be classified in class 2 than girls (OR=0.378, 95%CI=0.168-0.852), children with overweight/obesity and those with mothers with a University degree are more likely to be classified in class 2 (OR=1.759, 95%CI=1.113-2.732; OR=2.495, 95%CI=1.285-4.846, respectively).

Table 5: Associations (OR and 95%CI) between latent classes and biological and socio-demographic characteristics

Variables	Odds Ratio	95%CI	p value
Sex (Male)	0.378	0.168-0.852	0.019
BMI (Overweight/Obese)	1.759	1.113-2.732	0.012
Maternal Education			
<12 Grade	Reference		
Grade12/diploma/technical qualification	0.963	0.627-1.477	0.861
University	2.495	1.285-4.846	0.007
Household Income			
<12.000€	Reference		
12.000€-29.999€	0.724	0.474-1.105	0.134
≥30.000€	1.085	0.543-2.165	0.818
Maturity Status	0.266	0.489-1.219	0.402

Discussion

This study aimed to identify risk pattern profiles in Portuguese children aged 9-11 yrs old based on five health behaviors, as well as to estimate the effects of individual and socio-demographic characteristics in predicting risk class membership.

A high prevalence of overweight and obesity (≈46%) was found among Portuguese children which is not in complete agreement with previous studies with Portuguese youth. For example, Vasques et al. (2012) and Bingham et al. (2013) found a prevalence of about 30% in children and adolescents aged 3 to 13 years using the IOTF cut points. Sardinha et al. (2011) investigated Portuguese youth aged 10 to 18 years, and reported the prevalence of overweight and obesity contrasting two cut points - overall sample of 22.7% and 31.7% using the IOTF and WHO references, respectively. However, when only 10 years old children were considered, the prevalence was 45.3% for girls and 50.0% of boys using WHO cut points, which is in line with our results and, unfortunately, reflects the trend in pediatric overweight and obesity, especially in Western and developed societies (Janssen et al., 2005). However, the high prevalence found in the present study may well be a consequence of changes in children lifestyles mostly linked to their nutrition and other unhealthy behaviors, namely time spent in sedentary activities (Belahsen, 2014; Cecchini et al., 2010; Prentice-Dunn & Prentice-Dunn, 2012; Rey-Lopez et al., 2008).

Descriptive configural clustering of risk behaviors indicated that a large number of children showed a co-occurrence of different risks but with distinct frequencies: 10% had a configuration with all behavioral risks present, 78% had three or more risk configurations, and only 0.2% did not have any risk. Sleep time was the most prevalent risk behavior observed, followed by the consumption of fruits and vegetables, PA, screen time and consumption of sugary drinks. Sanchez et al. (2007), investigated time spent in PA and watching TV, daily intake of calories from fat, and daily serving of fruits and vegetables, and reported that nearly 80% of U.S. adolescents had multiple risk behaviors and almost half had at least three risk behaviors. Only 2% met all

guidelines. The most prevalent risk behaviors were related to diet (fruits and vegetables consumption and dietary fat) followed by PA and time spent watching TV. Similarly, Hardy et al. (2012), studied five potentially obesogenic behavioral risk factors (low PA, high screen time, low fruits and vegetable intake, high soft drink consumption and high snack intake) in Australian children, and reported that 51% of the boys and 43% of the girls reported three or more risk factors, and the co-occurrence of all five risk factors for both, boys and girls, was 160% greater than the proportion that would be expected by chance alone. None of these two studies included sleep time as a health behavior. However, a recent study conducted with U.S. children aged 9-12, and using accelerometer data (during 7 consecutive days) to estimate sleep time, concluded that 97% of children slept less than 10 hours per day (Wong et al., 2013), which is similar compares with our data. These results may be explained by the positive association between sleep time, higher caloric consumption and poorer dietary quality (Bel et al., 2013; Burt et al., 2014; Garaulet et al., 2011; Hitze et al., 2009). Additionally, Chaput (2013) and St-Onge & Shechter (2014) suggested that insufficient sleep may increase caloric consumption because: (1) there is more time and opportunities for eating; (2) there is possible psychological distress; (3) there is a greater sensitivity to food reward and (4) disinhibited eating; (5) more energy is needed to sustain extended wakefulness; and (6) changes in appetite hormones.

Two consistent and significant latent classes were identified. The labeling of latent classes reflects the posterior probabilities of individuals that meet the recommendations of health behaviors: class 1 "active, sedentary behaviors and poor eaters"; class 2 "inactive, good eaters". These results revealed that several healthy lifestyle factors, which can be related to the prevalence of some chronic diseases and obesity, not always occur simultaneously among children. Sabe et al. (2008), aimed to identify clusters on health behaviors based only on PA and eating habits found five clusters in children aged 10 yrs with a similar distribution of children among each cluster. However, clusters 1 (sporty healthy eaters) and 2 (sporty mixed eaters) comprised more males, the cluster 5 (sedentary healthy eaters) comprised more females, meaning that boys tend to

be more active/sporty than girls. Ottevaere et al., (2011) also examined the prevalence and clustering of PA, sedentariness and dietary patterns among European adolescents, and also identified 5 clusters. The two clusters with the highest prevalence (49%) were similar to the two classes found in the present study (”active, low diet quality cluster” and the “inactive, high diet quality cluster”). As regards to health behaviors explored in the present study, we were able to find only one study that investigated the same health behaviors in children using the same statistical approach (Magee et al., 2013). In this study, three latent classes (behavioral profiles) were identified: healthy (27.7%), sedentary (24.8%) and short sleepers/unhealthy eaters (47.5%). Additionally, they also examined the association between these behavioral profiles and obesity assessed in different time points, and concluded that the sedentary profile and short sleepers/unhealthy eaters profile were more likely to be obese at 2-year follow-up than subjects with healthy profile; further, subjects from sedentary profile were more likely to be obese at baseline than those from health profile. In our study, the more relevant difference between the two classes is related to the fact that most active children tend to drink more sugary drinks and eat less fruit and vegetables than less active ones. In addition, it was also observed that most active children spend more time watching TV or playing computer. These results may indicate that there is no association between time spend in MVPA and sedentary behavior, such as screen time (Marshall et al., 2004; Martinez-Gomez et al., 2010; Pate et al., 2008; Taveras et al., 2007). This result may partly explain the lower consumption of fruits and vegetables and the higher consumption of sugar drinks among most active children, since it seems to exist a relationship between TV viewing and unhealthy dietary behavior in children and adolescents (Pearson & Biddle, 2011).

The logistic regression results indicated that boys are less likely to be classified in class 2 (inactive, good eaters) than girls. It is well known that there is a sex differences in PA, that favors males (Crespo et al., 2013; Kettner et al., 2013; Verloigne, De Bourdeaudhuij, et al., 2012). A possible explanation for this difference (boys more active than girls) is that girls usually tend to devote less amount of time in PA or sports, and when they choose to do it their options are

usually for less competitive and intense activities (Seabra et al., 2008). Additionally, in Portuguese children these sex differences are usually observed and reported by Lopes et al. (2012; 2007), Martins et al. (2010) and Pereira et al. (2010). Such a consistent trend may be due to cultural perceptions that often favour boys in MVPA. Moreover, girls concerns about their body image, with a high interest to be lean (but not necessary fit) (Kanaan & Afifi, 2010), tend to increase their awareness about their feeding (to control or lose weight) (Harter, 2006) which, in turn, may explain their greater consumption of healthy food (such as fruit and vegetables) and lower consumption of unhealthy foods (such as sugary drinks and fast/junk foods). On the other hand, boys tend to meet the recommendations for less screen time more than girls, which is similar to previous studies (Russell Jago et al., 2014; te Velde et al., 2007). A possible explanation for these results may be due to the fact that screen time is probably not representative of the wide spread of children's sedentary behavior, and girls may choose to engage in other types of behaviors that were not assessed.

Present results also indicated that children with overweight/obesity and those with mothers with higher education level were more likely to be classified in class 2 (inactive, good eaters). Regarding weight status, there is no consensus about the relationship between overweight/obesity with PA levels, as some reports show a significant and positive relationship between these variables (R. Jago et al., 2005; Utter et al., 2007), while others did not find any significant relationship (Martins et al., 2010; Ribeiro et al., 2003). We found a negative relationship between BMI and PA, meaning that heavier children tend to be less active. Studies that reported this association, highlighted that children with overweight/obesity tend to present lower motor coordination levels and motor habilities development, leading to a decreased interest in PA's and, as consequence, with diminished MVPA levels. However, since weight excess can be a social problem for youth, it is possible that these children tend to try to weight loss by controlling their food consumption (D'Hondt et al., 2013; D'Hondt et al., 2009; Trost et al., 2001). Socio economic status also seems to have a relevant role in PA and feeding habits. In the present study those children from a higher SES (determined according to maternal education level) were more

likely to be inactive but good eaters. The results from other studies are not always clear about the magnitude and direction of this association (Steele et al., 2010), but there are some evidence that children from higher SES tend to spend more time in sedentary activities (Atkin et al., 2013; Foley et al., 2011), which can decrease time spent in PA, namely MVPA. As regards food habits, children from higher SES are expected to be exposed to a healthier environment, with easier access to healthy food, which can explain the fact that these children be more likely to classified as “good eater” (Béghin et al., 2014; Elsenburg et al., 2014).

This study has several limitations. Firstly, the present sample comes from only one Portuguese region (North of Portugal), and the results do not represent all Portuguese children. However, when comparing the present study sample characteristics with information available from same age and gender Portuguese children, no differences were found as regards the prevalence of overweight/obesity, the percentage of children attaining MVPA daily guidelines, and SES distribution (Baptista et al., 2012; Sardinha et al., 2011). Secondly, the use of an indirect method to determine nutritional habits and sedentary behavior can be prone to error. However, previous studies used similar instruments to measure these variables, meaning that they are useful and reliable instruments. Notwithstanding these limitations, the study has several important strengths: (1) the use of an objective method to estimate MVPA and sleep time; (2) the large sample size, from a specific age, that provides detailed information about a particular age; (3) the use of adequated and sophisticated statistical procedures to analyze configurations of behavioral risks and to identify latent classes; (4) the use of standard methods and a high reliable data.

In summary, two latent classes were identified, being the most prevalent (about 65%) characterized by physical inactivity, reduced sleep time and lower consumption of sugary drinks. Girls, children with overweight/obesity, and those with mothers with higher education levels, are more likely to be classified in the class characterized by lower levels of PA but with healthier dietary patterns. In general, children have distinct profiles of risk behaviors influenced by sex,

weight status and SES, which requires a special attention when planning intervention strategies to reduce these behaviors aiming to decrease the risk of development of chronic diseases in later life.

Perspectives

Quality of diet, PA levels, sedentary behaviour, and sleep time co-occur in distinct ways and are relevant for children's health, even though their effect is dependent upon specific individual and environment characteristics. As such, the results of this research should be taking into account when implementing intervention programs aiming to diminished the hazards associated with a sedentary lifestyle and obesity, namely by pointing profiles of children that seem to be in greater risk. Future research should focus on trying to further explore this risk classes, specifically by trying to disentangle how the different behaviors interact with each other in leading to obesity.

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Capítulo 4

Síntese Final e Conclusões Gerais

SÍNTESE FINAL E CONCLUSÕES GERAIS

Estilos de vida inadequados, tais como má nutrição, baixos níveis de atividade física, tempo de sono reduzido e tempo excessivo de ecrã (horas a ver televisão e/ou a utilizar computador), têm sido referenciados como fatores de risco de algumas doenças crónicas (Saunders et al., 2014; Tremblay et al., 2011), sendo a obesidade infantil um dos exemplos mais evidentes (te Velde et al., 2012). O desenvolvimento desta doença complexa está associado à ação conjunta de fatores biológicos, comportamentais e ambientais (Spruijt-Metz, 2011). Estes dois últimos, mais facilmente modificáveis, têm sido afetados pelas mudanças sociais, económicas e culturais, pelas quais as sociedades têm passado, com a oferta de "ambientes" que estimulam o sedentarismo (Cawley, 2004; Sturm, 2004). Por outro lado, alguns setores da indústria alimentar fornecem alimentos baratos e com baixa qualidade nutricional, enquanto que, o estilo de vida das populações tem sido movido por setores económicos que incentivam comportamento sedentários, disponibilizando formas atrativas de atividades de entretenimento e lazer, que promovem balanços energéticos positivos (Segel, 2011).

A infância e a adolescência têm sido caracterizadas como fases da vida pautadas pela diversidade, diferença e mudança. São uma espécie de janelas de oportunidade ímpares para implementar hábitos de vida saudáveis, ao mesmo tempo que são, também, momentos onde se adquirem comportamentos de risco, visto que os hábitos, atitudes e comportamentos assimilados nestes períodos alicerçam "muito" do que os jovens serão no futuro (Thorp et al., 2011). Daqui que a análise conjunta dos diferentes comportamentos, relacionados entre si, seja pertinente para compreender, melhor, o que diferencia crianças e adolescentes, ou classes de sujeitos assemelhados por grupos de características. Assim, um conhecimento mais esclarecido e multifacetado dos estilos de vida dos jovens permite a realização de estratégias de intervenção mais eficazes, promovendo "ambientes" físicos e sociais diferenciados que aumentem a qualidade de vida e os comportamentos saudáveis, reduzindo o risco de desenvolvimento de doenças crónicas associadas à obesidade e sedentarismo na vida adulta.

A presente pesquisa foi pensada e realizada precisamente no sentido de compreender aspectos dos comportamentos de risco que co-ocorrem nas crianças. Dos resultados obtidos e apresentados nos dois capítulos anteriores, foi possível elaborar o seguinte conjunto de conclusões:

Capítulo 2	***Change and stability in daily moderate-to-vigorous physical activity among 10 year old children*** 1. Níveis diários de atividade física modera a vigorosa (AFMV) apresentam uma tendência não linear marcada por um decréscimo ao fim de semana. 2. Crianças obesas têm maior propensão para não cumprir os 60 minutos diários de AFMV. 3. Há uma forte instabilidade nos níveis de AFMV ao longo de uma semana. 4. Estes resultados levantam novas questões acerca da importância da escola e efeitos do ambiente familiar na AFMV das crianças.
Capítulo 3	***Profiling children physical activity, diet, screen and sleep habits in Portuguese Children*.** 1. A agregação de fatores de risco foi observada em uma elevada percentagem de crianças portuguesas. 2. As crianças apresentam configurações distintas de comportamentos de risco, onde cerca de 80% acumula 3 ou mais desses comportamentos. 3. O reduzido tempo de sono é o comportamento de risco mais prevalente, seguido do baixo consumo de frutas e vegetais, baixos níveis de atividade física, excessivo tempo de ecrã e consumo de refrigerantes açucarados. 4. Foram identificadas duas classes latentes consistentes, sendo a mais prevalente (cerca de 65%) caracterizada pela inatividade física, tempo de sono reduzido e baixo

consumo de refrigerantes açucarados.

5. Raparigas, sujeitos com sobrepeso/obesidade, e sujeitos cujas mães apresentam nível mais elevado de escolaridade, têm maior propensão a ser classificado no grupo caracterizado por menores níveis de atividade física mas com padrão alimentar mais saudável.
6. Os resultados sugerem que as crianças têm perfis de comportamentos distintos, influenciadas por características individuais e sociodemográficas, que devem ser levadas em consideração aquando do desenvolvimento de programas de intervenção.

Para além dos resultados encontrados na presente pesquisa, há alguns pontos que merecem ser destacados acerca do delineamento e estratégias de análise da informação: a dimensão amostral; a idade escolhida (10 anos); o uso de métodos objetivos para estimar a atividade física (AF) e tempo de sono; o uso do acelerómetro 24 horas/dia, durante uma semana (7 dias), permitindo estimar a consistência e flutuação dos níveis de AF ao longo de uma semana típica das crianças; o uso de análises estatísticas “sofisticadas”. Contudo tem, também, alguns pontos “fracos” de que destacamos o mais importante – a amostra não ser representativa do país. Contudo, convém realçar que este nunca foi o propósito do próprio ISCOLE, embora algumas análises de informação (não mostradas nesta tese) tenham mostrado não haver diferenças substanciais entre os resultados obtidos nesta pesquisa e outros de dimensão nacional; por exemplo, relativamente à prevalência de sobrepeso/obesidade, a percentagem de crianças que atingem os níveis diários recomendados de AFMV, bem como a distribuição socioeconómica, os resultados encontrados no presente estudo são similares aos reportados em estudos com amostras representativas de Portugal Continental (Baptista et al., 2012; Sardinha et al., 2011).

Em nosso entender os resultados deste estudo são relevantes em termos de saúde pública, uma vez que levantam novas questões acerca da importância

da escola na promoção de ambientes e iniciativas que tenham por objetivo o aumento da AF/exercício físico/prática desportiva de modo a possibilitar que mais crianças cumpram as recomendações de AF diária (60 minutos de AFMV/dia). Consideramos, também, que deve ser dada uma atenção especial ao estatuto ponderal das crianças, com o desenvolvimento de estratégias de intervenção que levem em consideração o seu estatuto ponderal, uma vez que as variáveis correlatas da AF e sedentarismo, bem como hábitos saudáveis ou de risco, podem diferir em função desses valores. Acrescenta-se, ainda, que o envolvimento das famílias, numa perspectiva de educação para a saúde, abrangendo todos os comportamentos de risco que podem estar envolvidos no desenvolvimento de doenças crónicas, deve ser incluído no planeamento de programas de intervenção. A família é, inquestionavelmente, o "espaço" de organização social e pessoal de primeiríssima ordem na aquisição de hábitos e comportamentos saudáveis. Por outro lado, a identificação de grupos de crianças com distintos comportamentos de risco fornece informações relevantes que podem ser utilizadas nas fases de planeamento e desenvolvimento de estratégias por parte da escola ou de entidades que tenham como objetivo promover hábitos de vida saudáveis na infância e adolescência.

No contexto português, há um conjunto variado de entidades governamentais e organizações de caráter socioprofissional que centram a atenção tanto na prevenção primária, como na prevenção secundária, da obesidade infantil, envolvendo a família, escolas e todos os prestadores de cuidados infantis, por forma a produzir mudanças de hábitos e comportamentos nas crianças. Um bom exemplo é a Direcção Geral de Saúde que, ao disponibilizar a plataforma contra a obesidade infantil e criar programas como o PNPAS (Programa Nacional para a Promoção da Alimentação Saudável), visa aumentar a informação e recolha de dados sobre comportamentos alimentares. Um dos seus intuitos primeiros é modificar a disponibilidade alimentar e influenciar contextos, informando e capacitando os cidadãos através de um trabalho intersectorial e uma melhoria na qualificação e modo de atuação de profissionais. De igual modo, a Associação Portuguesa Contra a Obesidade

Infantil (APCOI) tem desenvolvido, desde 2010, um conjunto de iniciativas para valorizar a saúde das crianças, promover o combate ao sedentarismo ou a má nutrição e prevenir a obesidade infantil e todas as doenças a ela associadas. Num registo semelhante, ainda que mais limitado em termos de visibilidade e impacto, espera-se que os resultados do presente estudo auxiliem estas entidades no planeamento de estratégias futuras, contribuindo, no contexto português, para a redução de hábitos e comportamentos de risco entre crianças e jovens portugueses.

Não obstante o significado e alcance dos resultados da presente pesquisa, é nosso entendimento que estudos futuros devem partir de um maior espectro amostral, abrangendo outras regiões do país, por forma a obter uma amostra representativa de Portugal (continental e regiões autónomas). Similarmente seria importante aumentar o espectro etário, envolvendo crianças e adolescentes pré, púberes e pós-púbere, pode fornecer informações relevantes acerca de como os comportamentos de risco se agregam em crianças e adolescentes, sobretudo em fases marcantes do seu desenvolvimento. Dado evidências da existência de *tracking*, tanto em comportamentos saudáveis como em comportamentos de risco, seria da maior importância realizar estudos longitudinais para colher informação sequencial, uma vez que poderia fornecer resultados acerca do sentido e magnitude das mudanças (ou manutenção) de comportamentos na infância e adolescência, bem como a agregação destes comportamentos se modifica ao longo do tempo. Seria importante que o processo de recolha da informação abrangesse diferentes estações do ano, para pesquisar aspectos da variação sazonal em tais comportamentos. Finalmente, seria do maior interesse colocar à prova um ou mais programas de intervenção, ao estilo de ensaios clínicos, para se ajuizar a sua eficácia.

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