Antecedents of lifelong physical activity and the effects of lifestyle intervention and physical activity on psychological well-being

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ACADEMIC DISSERTATION

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ABSTRACT

Physical activity's benefits for well-being are widely known, but the prevalence of physical inactivity is high. The information concerning the antecedents of lifelong physical activity is lacking. The association between lifelong physical activity and psychological well-being also needs further studying. Moreover, there exists no evidence whether long-term lifestyle interventions containing physical activity counseling have psychologically beneficial effects. This thesis examined the childhood antecedents of lifelong physical activity (Studies I-II), the association between physical activity and depressive symptoms (Study III), and whether a 20-year intensive lifestyle intervention contributed to psychological well-being (Study IV).

The participants were from the Cardiovascular Risk in Young Finns Study (CRYFS) (Studies I-III), and from the Prospective, Randomized Trial of Atherosclerosis Prevention in Childhood Project (STRIP) (Study IV). Self-report questions and questionnaires were used in the studies. Studies I-IV were analysed using correlation tests, regression and variance analyses. Linear growth curve modeling, linear mixed modeling, and latent class growth analysis were were applied within studies I-III.

The results from the Study I indicated that high temperamental activity in childhood may contribute to the development of physically inactive lifestyle. Study II indicated that higher levels of parents' physical activity were associated with increased physical activity in offspring from childhood to middle age. Study III identified three distinct physical activity trajectory groups: the lightly, moderately, and highly physically active ones. Highly physically active participants had lower levels of depressive symptoms in adulthood compared with lightly physically active ones. The study also showed that lifelong physical activity did not contribute to depressive symptoms to a greater degree than adulthood physical activity. Adjustment for previous symptoms of depression attenuated the associations. Study IV showed no association between a 20-year, intensive lifestyle counseling and psychological well-being in adult age.

This thesis provides information that might benefit professionals in tailoring, timing and targeting physical activity promotion actions and interventions aiming at improving community well-being.

TIIVISTELMÄ

Fyysisen aktiivisuuden yhteydet hyvinvointiin ovat tunnetut, mutta fyysinen inaktiivisuus on yleistä. Lapsuusajan tekijöiden yhteyksiä tarkastelevia tutkimuksia elämänpituisten liikuntatottumusten kehitykseen ei juurikaan ole. Elämänpituisen liikunnan sekä psykologisen hyvinvoinnin välisiä yhteyksiä koskevia tutkimuksia tarvitaan myös lisää. Lisäksi ei ole lainkaan tietoa pitkäkestoisten, liikuntaneuvontaa sisältävien elämäntapainterventioiden psykologiseen hyvinvointiin liittyvistä vaikutuksista. Tässä väitöskirjassa tutkittiin lapsuusajan tekijöiden yhteyttä elämänpituisten liikuntatottumusten kehitykseen (osatyöt I-II), fyysisen aktiivisuuden yhteyttä masennusoireisiin (osatyö III), sekä 20-vuotisen, intensiivisen elämäntapaintervention yhteyttä psykologiseen hyvinvointiin (osatyö IV).

Tutkimukseen osallistujat kuuluivat Lasten Sepelvaltimotaudin Riskitekijät-projektiin (LASERI) (osatyöt I-III), ja varhaislapsuudessa aloitettuun Sepelvaltimotaudin Riskitekijöiden Interventioprojektiin (STRIP) (osatyö IV). Tutkimuksissa käytettiin itseraportointikysymyksiä ja -mittareita. Tutkimukset I-IV tehtiin hyödyntäen korrelaatio-, regressio-, ja varianssianalyyseja. Tutkimukset I-III analysoitiin lineaarisen kasvukäyrämallinnuksen, lineaarisen sekamallin, sekä latenttien kasvukäyrien mallinnusmenetelmien avulla.

Ensimmäisessä osatyössä osoitettiin, että lapsuuden korkea temperamentti saattaa olla yhteydessä fyysisesti inaktiivisen elämäntavan kehittymiseen. Vanhempien fyysinen aktiivisuus oli yhteydessä korkeampaan fyysiseen aktiivisuuteen heidän jälkikasvunsa lapsuudesta aikuisuuteen tutkimuksessa II. Tutkimuksessa III löydettiin kolme fyysisen aktiivisuuden kehityskaarta: kevyesti, keskimääräisesti ja korkeasti fyysisesti aktiiviset. Elämänpituinen fyysinen aktiivisuus ei ennustanut masennusoireiden kehittymistä paremmin kuin fyysinen aktiivisuus aikuisiässä. Korkeasti aktiivisilla oli vähemmän masennusoireita aikuisuudessa kuin matalasti aktiivisilla, mutta yhteydet hävisivät aikaisempien masennusoireiden vakioinnin myötä. Osatyössä IV osoitettiin, ettei 20-vuotisella, intensiivisellä elämäntapainterventiolla ollut psykologiseen hyvinvointiin liittyviä vaikutuksia aikuiässä.

Väitöskirjan informaatio on todennäköisesti hyödyksi sellaisten fyysisen aktiivisuuden lisäämistä käsittelevien hankkeiden ja interventioiden suunnittelussa, ajoittamisessa ja kohdentamisessa, jotka tähtäävät kansanterveyden edistämiseen.

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In Helsinki, 27th September 2017

Kaisa Kaseva

“The first wealth is health.”

– Ralf Waldo Emerson

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following publications:

I Yang X, Kaseva, K., Keltikangas-Järvinen, L., Pulkki-Råback, L., Hirvensalo, M., Jokela, M., Hintsanen, M., Hintsa, T., Kankaanpää, A., Telama, R., Hutri-Kähönen, N., Viikari, J., Raitakari, O., & Tammelin, T. (2017). Does childhood temperamental activity predict physical activity and sedentary behavior over 30 years? Evidence from the Young Finns Study. *International Journal of Behavioral Medicine, 24,* 171-179.

II Kaseva, K., Hintsa, T., Lipsanen, J., Pulkki-Råback, L., Hintsanen, Yang, X., Hirvensalo, M., Hutri-Kähönen, N., Raitakari, O., Keltikangas-Järvinen, L., & Tammelin, T. (2017). Parental physical activity associates with offspring's physical activity until middle age: A 30-year study. *Journal of Physical Activity & Health, 14,* 520-531.

III Kaseva, K., Rosenström, T., Hintsa, T., Pulkki-Råback, L., Tammelin, T., Lipsanen, J., Yang, X., Hintsanen, M., Hakulinen, C., Pahkala, K., Hirvensalo, M., Hutri-Kähönen, N., Raitakari, O., & Keltikangas-Järvinen, L. (2016). Trajectories of physical activity predict the onset of depressive symptoms but not their progression - a prospective cohort study. *Journal of Sports Medicine, 2016,* 8947375, 9.

IV Kaseva, K., Pulkki-Råback, L., Elovainio, M., Pahkala, K., Keltikangas-Järvinen, L., Hintsanen, M., Hakulinen, C., Lagström, H., Jula, A., Niinikoski, H., Rönnemaa, T., Viikari, J., Simell, O. & Raitakari, O. (2015). Psychological wellbeing in 20-year-old adults receiving repeated lifestyle counselling since infancy. *Acta Paediatrica, 104,* 815–822.

ABBREVIATIONS

WHO	World health organization
CRYFS	Cardiovascular risk in young Finns study
STRIP	Prospective, randomized trial of atherosclerosis prevention in childhood project
APA	American psychological association
ICC	Intraclass correlation coefficient
BDI	Beck depression inventory
GPA	Grade point average
MCAR	Missing completely at random
WLSMV	Weighted least squares means and variance adjusted
CFI	Comparative fit index
TLI	Tucker-Lewis index
RMSEA	Root-mean square error of approximation
ML	Maximum likelihood method
LCGA	Latent class growth analysis
ANOVA	Analysis of variance
AIC	Akaike's information criterion
EM	Expectation-maximization
ADHD	Attention deficit hyperactivity disorder

1 INTRODUCTION

1.1 Psychological well-being

Recent studies in psychology highlight the idea of understanding psychological well-being in terms of positive psychological functioning, i.e., through the strengths and determinants of well-being (Ryff, 1995; Ryff & Singer, 2008). Subjective well-being, relying on the hedonic perspective, has been regarded as a one traditional way for defining psychological well-being (Diener et al., 2002). This concept reflects the experiences of the quality of an individual's life, as well as both emotional reactions and cognitive judgments regarding it (Diener et al., 2002). A concept of eudaimonic well-being has been presented (Ryan & Deci, 2001) as a complementary perspective to a hedonic one, which accentuates the importance of the actualization and expression of all the capacities of self. The hedonic and eudaimonic perspectives have been integrated in Ryff's (Ryff, 1989; Ryff & Singer, 2008) theory, which suggests that self-acceptance, inner growth, purpose in life, positive relations with others, environmental mastery, and autonomy are the most essential ingredients of psychological well-being.

Life course epidemiology studies long-term effects of biological, psychosocial and behavioral factors on well-being through distinct developmental stages (Kuh et al., 2003; Ben-Shlomo et al., 2014). The purpose of life course epidemiology is to build and test models that link biological, psychosocial and behavioral factors to health (Kuh et al., 2003). The literature has denoted that these factors contribute to well-being independently, cumulatively, and interactively (Kuh et al., 2003). It has also been suggested that early experiences and adaptive responses may affect health development, without having a deterministic effect (Halfon & Hochstein, 2002). Studies regarding well-being in life transitions have denoted that many individuals actively shape the meaning of life experiences, aim to resolve the stressors to their satisfaction, and hence gain information of their strengths and capacities through the life course (Aldwin et al., 1996; Thoits, 1994; Turner & Avison, 1992). It has also been postulated that there exists individual differences within psychological resilience, referring to the ability to bounce back from negative events by using positive emotions as coping mechanisms, which is likely to have long-term effects on well-being (Tugade et al., 2004).

Based on life course epidemiology (Kuh et al., 2003) and Ryff's & Singer's (2008) perspectives, psychological well-being evolves through the life course. According to Ryff's & Singer's (2008) ideas, it also has the potential to increase as the person matures. Previous studies

have given supportive evidence to these suggestions, demonstrating that there is an age-related increase in experienced well-being, although some decline seems to occur in old age (Baird et al., 2010). It has also been suggested that experienced well-being develops in a curvilinear shape from childhood to old age (Blanchflower et al., 2008). To date, the causes for the development of well-being have not been thoroughly studied (Blanchflower et al., 2008). Overall, factors that potentially independently, cumulatively and interactively affect well-being over the life course require further examination (Kuh et al., 2003).

In many multidisciplinary settings, researchers have assessed psychological well-being over the life course with ways that best reflect the health perspectives under interest. Hedonic, eudaimonic and also physical health related aspects have been taken under consideration in these assessments. Many large-scale observational, and intervention studies rely on self-reports, in which single questions or short questionnaires have been used in assessing well-being (Fayers & Sprangers, 2002; Bowling, 2005; Chen et al., 2008). Brief measures have been preferred in most cases due their efficiency and cost-effectiveness (Fayers & Sprangers, 2002; Bowling, 2005). In many clinical trial designs, such measures have also been regarded as important alongside physical measurements (Fayers & Sprangers, 2002; Chen et al., 2008). For instance evaluations of one's life's quality, ease of every-day functioning, routine management, the presence or absence of symptoms of mental health disorders, as well as symptom severity have been often addressed using concise questions and questionnaires. Such questions reflect the relevant aspects of psychological well-being, including the cognitive and emotional ones, and mastery. The present thesis focuses on evaluations of well-being reflecting both the hedonic, and partly Ryff's (1989) perspectives of well-being. These aspects of well-being have been assessed with single-item questions and concise questionnaires that also link to physical health. The term psychological well-being is used to reflect these question and questionnaire responses.

1.2 Lifestyles

Along with biological and psychosocial attributes, lifestyle related behavioral factors contribute to well-being during the life course (Kuh et al., 2003). Lifestyle has shown to be one of the most essential determinant of global health (Lichtenstein et al., 2006; WHO, 2010). Unhealthy diet, tobacco, extensive use of alcohol, and physical inactivity increase the risk of variety of mental health and somatic diseases, and mortality (WHO, 2013, 2014). For instance, physical inactivity has been estimated to cause 6% of the burden of illness from coronary heart disease, 7% of type 2

diabetes, and 10% of breast and colonial cancers worldwide (Lee et al., 2012). Approximately 3.2 million deaths yearly have been attributed to insufficient physical activity (WHO, 2010). Furthermore, 1.7 million annual deaths have been regarded to be caused by unhealthy diet (Mozaffarian et al., 2014). Tobacco accounts for around 6 million deaths every year (WHO, 2013), and over 3 million annual deaths are from harmful drinking (WHO, 2014). To achieve and maintain both physical and psychological well-being, healthy diet, avoidance of tobacco and drug use, avoidance of extensive amounts of alcohol drinking, and being physically active have been recommended (Lichtenstein et al., 2006).

Research suggests that lifestyles' development is originated in childhood (Berenson et al., 2002; Halfon & Hochstein 2002; Simell et al., 2009; Hirvensalo & Lintunen, 2010). It has also been postulated that lifestyles tend to be relatively stable from childhood to adulthood (Telama et al., 1996; Simell et al., 2009; Telama et al., 2014). Lifestyles have also shown to have cumulative effects on health, which indicates that well-being is not simply a consequence of a certain circumstance but the result of circumstances that develop over time (Hatch, 2005). Thus, the number and type of health risk factors and protective elements can result in different behavioral trajectories that relate with distinct levels of well-being (Halfon & Hochstein, 2002). For instance, unhealthy behavioral factors accumulate over the life course and are associated with decreased physical and psychological health (O'Rand & Hamil-Zucker, 2005; Elovainio et al., 2015). Research has also demonstrated that cumulative experiences of health contribute to the formation of lifestyles (Wickrama & Wickrama, 2010). According to life course perspectives, it is important to study early life factors in conjuction with later life contributors in order to identify risk and protective processes for healthy lifestyles (Kuh et al., 2003; Hirvensalo & Lintunen, 2010).

1.2.1 Physical activity

Among the lifestyle factors, physical activity is one of the most influential ones contributing to global health (WHO, 2010). Physical activity has been defined as any physical movement produced by skeletal muscles that requires energy expenditure (WHO, 2010). This term includes all forms of physical activity, ranging from activities involved in daily living to competitive sports (Miles, 2007). Physical inactivity, on the contrary, has been described as a state, in which physical movement is minimal and energy expenditure nears the resting metabolic rate (IARC, 2002). Physical activity can be further classified with respect to frequency, duration and intensity of the

activity. Frequency and duration indicate how often and how long an activity is performed, and intensity refers to the degree of energy expenditure that an activity requires (Miles, 2007).

World Health Organization (WHO) has designed global guidelines that address the links between the frequency, duration, intensity, type and total amount of physical activity needed for the prevention of diseases (WHO, 2010). Based on these recommendations, children and adolescents aged 5 to 17 years should participate in at least 60 minutes of moderate to vigorous physical activity per day. Adults from 18 years on should do at least 150 minutes of moderate-intensity aerobic physical activity per week. It has been denoted that exceeding these recommendations provide additional health advantages (WHO, 2010). Despite the well documented benefits of physical activity, inactivity has increased, and many age groups from childhood to late adulthood are not meeting the recommended levels of physical activity (e.g., Wendel-Vos et al., 2007; Hallal et al., 2012).

Physical activity has shown to be relatively stable from childhood to adulthood (Telama et al., 1996) along with other health behavioral styles. It has been suggested that the origins of physical activity are in early life conditions and experiences (Hirvensalo & Lintunen, 2010). According to life course perspective, polarization of exercise to the active and inactive portions of population also tends to accumulate over time (Hirvensalo & Lintunen, 2010). It has been postulated that psychobiological, social and socioeconomic factors may affect people's tendency to maintain their physical activity levels (Hirvensalo & Lintunen, 2010). Consequently, it is possible that different physical activity trajectories contribute to distinct health outcomes. Along with physical activity's immediate benefits for health (WHO, 2010), it has been stated that long-term physical activity associates with improved well-being (Blair et al., 1992; Must & Tybor, 2005; Schnohr et al., 2006; WHO, 2010). It is, however, worth noticing that although regular physical activity plays an important role in health maintenance through life course (Berczik et al., 2012; WHO, 2010), extremely excessive exercising may not lead to improved health outcomes (Berczik et al., 2012). To date, studies assessing the relationship between lifelong physical activity and health outcomes, such as psychological well-being, are rare, and there is a need for such examinations (Muñoz et al., 2010).

1.2.2 Sedentary behaviors

Sedentary behaviors have been recognized as important study targets when evaluating physically active lifestyle's and health's association (Owen et al., 2010). Sedentary behaviors have been

considered consisting of a set of behaviors that involve sitting and low levels of energy expenditure, such as TV viewing, computer and electronic game use, workplace sitting, and time spent in automobiles (Owen et al., 2010). Thus, sedentary behaviors should not be defined simply as the absence of moderate-to-vigorous physical activity (Owen et al., 2010). Physically inactive lifestyle has been suggested to be originated in childhood (Halfon & Hoschstein, 2002; Hirvensalo & Lintunen, 2010). Along with the psychobiological, -social and socioeconomic factors (Hirvensalo & Lintunen, 2010), it has been denoted that urbanisation and technological development contribute to sedentary behaviors over the life course (Kirchengast, 2014). Sedentary behaviors have shown to associate with unfavorable health outcomes over childhood and adolescence (Must & Tybor, 2005), and adulthood (Proper et al., 2011). Specifically, TV viewing has been regarded as a one of the most prevalent sedentary behaviors in adulthood (Clark et al., 2011), and high levels of TV viewing have been found to be more detrimental to health than computer use and driving (Basterra-Gortari et al., 2014). Studying factors that contribute to the formation of inactive lifestyles has been encouraged (Hirvensalo & Lintunen, 2010; Kirchengast, 2014). Furthermore, more information of the potentially critical periods in engaging or quitting sports participation during life course is needed (Hirvensalo & Lintunen, 2010).

1.3 Antecedents of physical activity

As most lifestyle related diseases develop through a lifelong process, their prevention should be initiated at an early age (Simell et al., 2009). To design effective health promotion and interventions, it is important to examine and identify factors that contribute to the development and maintenance of physically active or sedentary lifestyles (Øglund et al., 2014; Holt & Talbot, 2011). The essentiality of studying the role of physical activity in various life transitions has also been acknowledged (Hirvensalo & Lintunen, 2010). To date, early life factors' association to the development of physically active lifestyle and sedentariness are not well-explored (Øglund et al., 2014). Childhood psychobiological and –social determinants, such as temperament traits and parental lifestyles, have been considered highly important in these examinations (Lau et al., 1990; Øglund et al., 2014). Furthermore, the need for studying the early life determinants in conjuction with later life factors has been accentuated when aiming at understanding lifestyles and health outcomes (Kuh et al., 2003).

1.3.1 Childhood temperament

Temperament characteristics, the foundations of individuality, associate with the development of lifestyles (e.g., Anderson et al., 2004). Studies of temperament became central themes within developmental psychology and child psychiatry around 1980s (Zentner & Bates, 2008). According to Thomas' and Chess' (1963, 1977) studies, a child's temperament consists of nine behavioral dimensions, including activity level, rhythmicity, approach/ withdrawal, adaptability, sensory threshold, intensity of reaction, quality of mood, distractibility, and attention span/ persistence. Thomas & Chess (1977) regarded temperament equal to behavioral style, with a special emphasis on how a person reacts, and why.

Goldsmith and Campos (1982) defined temperament as individual differences in the primary emotions (i.e., joy, interest, sadness, anger, fear), and in their regulation. Individual differences within these emotional predispositions are expressed in variety aspects of behavior, including vocal, facial, and motor expressions. Although Goldsmith and Campos (1982) did not accentuate the genetic origins of the traits in their pioneering work, heritability aspects of temperament were considered later on (Goldsmith et al., 1999). The associations between emotions and their regulation were also key determinants of temperament in Rothbart's theory, which suggests that temperament reflects constitutional differences in reactivity and self-regulation that are linked to neurobiological mechanisms (Rothbart & Derryberry, 1981).

Kagan and his colleagues studied children's behavioral inhibition and unhibition to unfamiliar things and situations, with a special focus on the autonomic nervous system functioning (Kagan et al., 1988). The studies revealed that children who avoided or got stressed in unfamiliar situations had a greater sympathetic tone in the cardiovascular system, whereas children showing minimal avoidance or distress in the same situations had a greater parasympathetic tone. The behavioral styles and their biological manifestations have shown to be relatively stable (Kagan et al., 1988), and thus temperament was regarded as behavioral style that associates with biological predispositions.

Temperament traits have also been suggested to consist of a child's activity level, sociability, and emotionality (Buss & Plomin, 1984). According to Buss & Plomin's theory, temperament refers especially to a child's tendency to react and speed of his or her reactions to outside influences (Buss & Plomin, 1975; 1984). Activity refers to the need for moving, the amount of energy that an individual uses for his or her actions, and the speed of his or her behaviors. Sociability refers to a child's preference to be with others and share activities with them, and

emotionality to his or her tendency to experience and express emotions. Buss & Plomin (1984) accentuated the cognitive, emotional and behavioral aspects of temperament, and also the traits' genetic origins.

Researchers have thus given different emphasis to the role of biology, and ended up to slightly distinct suggestions regarding the core dimensions of temperament. For summarizing purposes, it has been suggested that Buss & Plomin's (1984) theory presents the key ingredients for temperament (Zentner & Bates, 2008). Temperament traits can thus be defined as biologically based, partly inherited tendencies of thinking, feeling and expressing emotions, and behavioral styles that comprise a core component of personality (Buss & Plomin, 1975; 1984). This definition is also adopted to this study.

Some studies regarding temperamental characteristics, physical activity and sedentary behaviors have shown that high temperamental activity associates with increased physical activity in children (e.g., Øglund et al., 2014). Previous studies on individual dispositions and physical activity have shown that extroverted adults have higher levels of physical activity, whereas neurotic ones tend to be physically more inactive (Rhodes & Smith, 2006; Brunes et al., 2014). Literature has also demonstrated that lack of self-regulation associates with unhealthy behaviors in adults (van den Bree et al., 2006). Longitudinal studies on early life factors and physical activity are sparse. Among temperament traits, activity might be of the utmost importance regarding the development of physical activity, as the trait is related to a high need for moving. It has also been denoted that movement skills in early life affect the development of childhood physical activity (Øglund et al., 2014). However, a high level of temperamental activity in childhood may increase the risk for cardiovascular disease in adulthood (Keltikangas-Järvinen et al., 2006), although physical activity is known to be one of the protective factors for cardiovascular disease. To date, examinations concerning the potential association between childhood temperamental activity and the development of physically active lifestyle are lacking.

1.3.2 Parents' physical activity

Early social environmental factors contribute to the development of lifestyles (e.g., Lau et al., 1990; Lamb, 2004). Parents' health behaviors, including their physical activity habits, have been suggested to contribute to the development of their children's lifestyles from early childhood on (Lau et al., 1990). It has been suggested that daughters identify especially with their mothers'

behaviors, and sons with those of their fathers (Hill & Lynch, 1983; Grusec, 1992). More recent examinations concerning the associations between parents' and children's physical activity habits have given supportive evidence to these views (DiLorenzo et al., 1998; Cheng et al., 2014) but there are also differing results. Some evidence has demonstrated that mothers' physical activity associates with children's physical activity in both sexes (Pahkala et al., 2007; Karppanen et al., 2012). Other studies have accentuated fathers' physical activity's importance in predicting offspring's late childhood and adolescent physical activity (Yang et al., 1996; Yang et al., 2000).

The association between parents' and their children's physical activity may be related to observations children make of their parents' behavior, and thus parents may be important referents and socialization agents for their offspring (Lau et al., 1990; Chan et al., 2012). Later on, teachers, leisure-time activity leaders and peers may become essential socialization agents along with parents (Chan et al., 2012). Parents may have influence on their children also through guiding, supporting, and by being their companions (Moore et al., 1991). It has also been suggested that activities which are performed together promote children's skills development, which may foster self-confidence and enjoyment, and contribute to further involvement on these activities (Lamb, 2004). Furthermore, parents may be essential facility and equipment providers for their offspring. The association between parents' and children's physical activity may also be partly explained by genetic factors which may predispose a child to specific levels of physical activity (Moore et al., 1991).

To date, relatively much research regarding the effects of parental physical activity on that of their children's exist, but the evidence of how far-reaching these effects actually are, is lacking. There neither exists evidence whether both parents' physical activity contributes similarly to daughters' and sons' physical activity from childhood to adulthood. Furthermore, it has also been denoted that more research focusing on the question to what degree physical activity behaviors is a function of the individual and/ or environmental factors is needed (Bauman et al., 2012).

1.3.3 Lifestyle counseling

Along with other early life correlates, also lifestyle counseling procedures started in childhood have shown to be associated with the development of health behaviors (Blank et al., 2007; Simell et al., 2009). Lifestyle interventions may contain counseling regarding physical activity, nutritional habits, smoking and substance abuse. Such procedures usually aim at permanent lifestyle modifications. Lifestyle interventions have shown to be effective in childhood, adolescence and

adulthood (e.g., Simell et al., 2009). While the evidence of the potential side-effects of dietary interventions (Talvia, 2013) is scarce, few studies have examined the psychological outcomes of lifestyle interventions and whether psychological health promotion programmes associate favorably with indicators of psychological well-being (Wells et al., 2003; Melnyk et al., 2009; Blank et al., 2007).

To date, the prospective, randomized trial of atherosclerosis prevention in childhood (STRIP) is a unique lifestyle intervention that has continued from infancy to adulthood for 20 years. The STRIP study was designed to promote healthy dietary and lifestyle choices. Health professionals delivered the dietary intervention based on current nutritional guidelines aimed at a fat intake for a child of 30% to 35% of daily energy, a saturated to monounsaturated + polyunsaturated fatty acid ratio of 1:2, and cholesterol intake of <200 mg/day (Simell et al., 2009; Pahkala et al., 2013). Furthermore, intervention givers promoted the intake of vegetables and fruits, wholegrain products, a low intake of salt, and avoiding unnecessary larger portion sizes. Initially, participants' parents primarily received intervention, whereas progressively more counseling targeted children from their age of 7 years. Health professionals provided counseling at every study visit at least biannually. The counseling was individualised, and a child's food record was used as a basis for suggestions without prescribing a fixed diet. In addition to diet, child-oriented counseling aimed at primary prevention of smoking began at the children's age of 8 years. Counseling also included discussion and guidance concerning a physically active lifestyle. For instance, children's hobbies were discussed and habitual leisure-time physical activity was encouraged during the sessions. Furthermore, the counseling aimed at preventing alcohol and drug use. Control group received the standard healthcare education.

The STRIP intervention focused on improving physical health may have also affected psychological well-being (Prince et al., 2007; Sarafino & Smith, 2014) due to its content, length, and intensity. From the child's age of 10 years on, counseling sessions focused on themes such as identity, decision-making capacities, self-determination, self-esteem, and social relationships. The long-term intervention also considered how these themes linked to health behaviors such as physical activity, and physical and psychological well-being. The psychological and neurological safety of the STRIP study was assessed during subjects' childhoods (Tarmi-Mattson et al., 1997; Saarilehto et al., 2001, 2003; Rask-Nissilä et al., 2000). To date, there exists no evidence of whether the dietary and lifestyle trial, in which the intervention was given for 20 years from childhood to adulthood, contributes psychological well-being in adult age.

2 AIMS OF THE THESIS

Healthy lifestyles are associated with improved psychological well-being which also links to better health (Prince et al., 2007; Sarafino & Smith, 2014). To date, there is a lack of evidence of how far-reaching the effects of some antecedents and determinants are, i.e., whether certain individual and social predictors assessed in early age associate with physical activity from childhood to middle adulthood. Further information of whether lifelong physical activity habits associate with psychological well-being in adulthood is also needed. Furthermore, there is no evidence of whether a 20-year lifestyle intervention focused on dietary and physical activity promotion associates with psychological well-being in adulthood, i.e., whether such procedure carries unintended psychological benefits or risks.

The Study I focused on assessing whether childhood temperamental activity associated with the development and maintenance of physically active lifestyle. It was hypothesized that there may be an innate temperament trait that regulates one's need for moving which may lead to physical activity, but the effects of temperamental activity on the development of physically active lifestyle from childhood to adulthood are unknown.

The Study II focused on examining whether parents' physical activity associated with the development and maintenance of physical activity from childhood to adulthood. It was hypothesized that both parents' physical activity has the potential to have far-reaching effects on offspring up to adulthood.

The Study III examined whether and how physical activity trajectories from childhood to adulthood contributed to symptoms of depression in midlife. It was hypothesized that physically active lifestyle is likely to associate with decreased levels of depressive symptoms in adulthood.

The Study IV assessed whether the intensive, 20-year lifestyle intervention had psychological effects on participants in adult age. It was hypothesized that the intervention may have carried psychological benefits, but we did not rule out the possibility that the intervention might have had unintended, unfavorable effects on participants.

Studies I-III were conducted within over a 30-year, prospective, population-based cohort design. Study IV was performed in a 20-year prospective, randomized intervention design. As life course perspective accentuates the importance of studying early life factors jointly with later life contributors in relation to life-styles, and identifying risk and protective processes for well-being (Kuh et al., 2003), a set of covariates assessed from childhood to adulthood were examined within

the studies described above. The study variables and their measurement phases are presented in the Supplementary Table 1.

2.1 Theoretical model

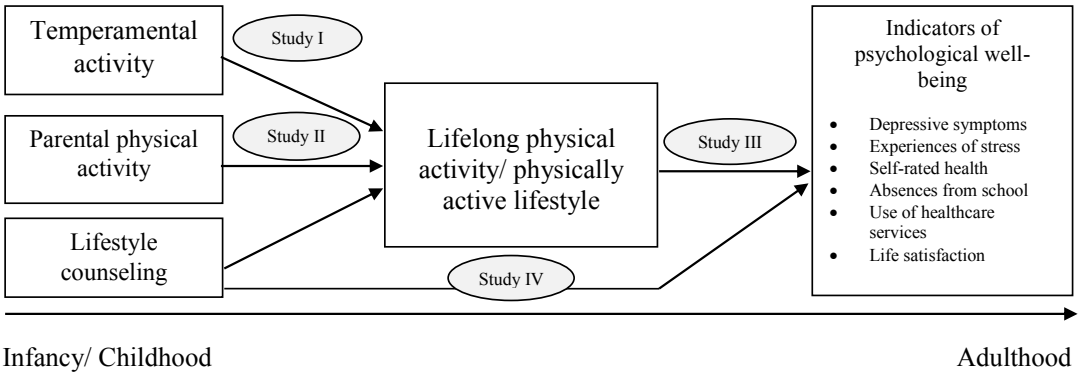

Figure 1. Antecedents of lifelong physical activity, and the effects of lifestyle intervention and physical activity on psychological well-being

3 METHODS

3.1 Study designs and participants

3.1.1 Cardiovascular Risk in Young Finns Study (CRYFS)

In the Studies I-III, the data from the ongoing Cardiovascular Risk in Young Finns Study (CRYFS) which began in 1980 was used (Raitakari et al., 2008). The 3596 children and adolescents (83.2% of those invited, 1832 women and 1764 men) from six birth cohorts (aged 3, 6, 9, 12, 15 and 18) took part in the study. To acquire a representative sample, Finland was divided into five areas based on the locations of universities with medical schools (Helsinki, Kuopio, Oulu, Tampere, and Turku), and the participants were randomly chosen based on their social security identification numbers from nearby urban and rural areas. The sampling frame was the Social Institution's population register, which includes the whole Finnish population and is continually updated. Practically, each age cohort's females and males within each district were separately placed in random order based

on their personal identification number. Every k^{th} female and every k^{th} male within each area was chosen in a way that the sample contained the required number of females and males. The varying k factors were determined on the basis of sample size and the total number of females and males within different age cohorts in each area.

The sample was followed in 8 waves, 1983, 1986, 1989, 1992, 1997, 2001, 2007-2008, and 2012, during which medical, psychological and physical-activity studies were conducted. Physical activity from childhood to middle adulthood was assessed in 1980, 1983, 1986, 1989, 1992, 2001, 2007 and 2011, response rate ranging from 53.1% to 72.8% (N=1910-2619) of the original study participants.

Studies of sample attrition have shown that there has not been systematic selection bias with respect to study participants' medical profiles or physical activity (Raitakari et al., 2008; Telama et al., 2000; Yang et al., 2012), but some selective attrition regarding personality and depressive symptoms exists (Rosenström et al., 2012a, 2012b). Subjects who were less self-directed, less agreeable, and had higher levels of neuroticism as well as depressive symptoms had discontinued the participation more often than others (Rosenström et al., 2012a, 2012b). Furthermore, some selective attrition with regard to participants' childhood socioeconomic status was found ($p<0.05$). Sixty-two percent (N=548) of the participants with high childhood socioeconomic status (based on parental education in the baseline, 1980) had continued in the study, whereas the number of continuers was 56.6% (N=695) within participants with low socioeconomic status.

3.1.2 Prospective, Randomized Trial of Atherosclerosis Prevention in Childhood Project (STRIP)

In the study IV, the data from a Prospective, Randomized Trial of Atherosclerosis Prevention in Childhood Project (STRIP) was used. Participant families from the Turku region of Finland were invited to the STRIP study between 1989 and 1992 during routine five-month-old well-baby clinic visits. From the original STRIP cohort, 1062 infants were randomised into either the intervention or control groups (Simell et al., 2009). Parents were initially the primary recipients of the counseling, but counseling increasingly targeted children from the age of seven years on and continued until participants' age of 20. Control group received only the standard healthcare education given to all Finnish children at well-baby clinics and schools. Intervention group was prospectively followed at least two times per year from infancy to adulthood, and control group was followed at least once per year throughout the same study period (Simell et al., 2009). The primary outcome measures of the STRIP study were the intake of nutrients, particularly dietary fat quality, and the concentrations of

serum lipoproteins as well as other cardiovascular risk factors. In addition, e.g. neurological and psychological factors were examined in participants' childhood and adult age. Of the 1062 original participants, 457 (43%) completed the 20-year psychological survey (used in this thesis' Study IV), and 210 (46%) of them were intervention receivers and 247 (54%) controls.

Studies of sample attrition with respect to participants' physiological characteristics showed no significant difference between children who remained in the study and those who discontinued their participation, for instance when it came to total serum cholesterol or saturated fat intake (Raitakari et al., 2005). The discontinuing and continuing participants did not neither differ regarding their socioeconomic, psychological or neurological baseline characteristics (Kaseva et al., 2015). Furthermore, the discontinuing and continuing subjects did not differ in terms of their physical activity (assessed at the age of 13) ($p>0.05$) (continuing group: N=454, mean=27.10; discontinuing group: N=134, mean=27.92).

3.1.3 Study ethics

Prior to initiating the CRYFS study, informed consent was requested from each participant (or from the parents of small children), and the study was approved by the local ethics committees. The study was conducted according to Declaration of Helsinki, revised in 1983, and also according to American Psychological Association's (APA) ethical guidelines.

At the beginning of the STRIP project, an informed consent was obtained from the children's parents. The Joint Commission on Ethics of Turku University and Turku University Central Hospital approved the study. The study procedure (STRIP19902010, unique identifier: NCT00223600, clinicaltrials.gov) was in accordance with the Declaration of Helsinki, revised in 1983. In addition, the treatment of the sample complied with the American Psychological Association's (APA) ethical guidelines.

3.2 Measures

3.2.1 Participants' temperamental activity (Study I)

Participants' temperamental activity was assessed via maternal ratings in 1980 (Wells, 1980). Items reflecting temperamental activity focused on a child's motor activity, a child's desire to move, and his or her tendency to behave in a restless manner. Participants' mothers were requested to respond

to the following question: “Which of the following describes your child most accurately?” The four alternative responses were 1) My child is always controlled, stays calm even in situations where most children would become restless, 2) My child is overactive or restless only occasionally, for instance when tired, 3) My child is continuously more restless than the average child or youth, and 4) My child is constantly moving and energetic, even restless. The means of question responses were calculated for each participant. The scale has shown to be valid (Pesonen et al., 2003; Pulkki-Råback et al., 2005; Katainen et al., 1997).

3.2.2 Participants’ physical activity (Studies I-III)

In the study I, children’s physical activity at the ages of 3 to 6 was determined using maternal ratings (Telama et al., 1985). Mothers responded questions regarding their children’s outside playtime (hours per day), how much the child moves when playing compared to others of the same age, the vigorousness of the child’s physical activity, the child’s enjoyment of inside/ outside playing, the child’s general level of physical activity comparing to others of the same age, the encouragement given to him or her to participate in sports, and the patterns of physical activity. The items were rated using a 3-point scale (1 = low, 2 = moderate, and 3 = high), with the exception of the item that reflected the encouragement to engage in sports, which was evaluated via a 2-point scale (1 = no, 2 = yes). Physical activity index was computed by summing up the responses, values ranging from 8 to 23 (Telama et al., 2014). Previous findings have given evidence for predictive validity of mothers’ ratings concerning children’s physical activity (Telama et al., 2014).

Participants’ physical activity was studied with self-report questionnaires from school age to adulthood (from 9 to 49 years). Participants' physical activity from 1980 to 1989 was studied with 5 questions assessing the frequency and intensity of leisure-time physical activity, participation in sports-club training and sports competitions, and the usual way the participants spent their free time (Telama et al., 1985). From 1980 to 1989, the questions’ responses were coded into 3 categories (ranging from 1 to 3) except the item assessing participation in sports competitions, with which a 2-point scale was used. The specific questions were the following: 1) How often do you engage in leisure-time physical activity for at least half an hour per session? 2) How much breathlessness and sweating do you experience when you engage in physical activity and sport? 3) How many times a week do you usually engage in training sessions organized by a sport club? 4) Do you participate in sports competitions? 5) What do you usually do in your leisure time?.

From year 1992 on, the items within questionnaires were adjusted to reflect subjects' physical activity in adulthood. The question concerning participation of sports competitions was excluded from the questionnaire, as it was not considered as a suitable indicator for adulthood physical activity. The sentence structures of other questions and response options were also slightly changed. From year 1992 on, the intensity of physical activity, frequency of vigorous physical activity, hours spent in vigorous physical activity, average duration of a physical activity session, and participation in organized physical activity were studied via 5 questions (Telama et al., 2005; Yang et al., 2012). In 1992, the questions' responses were coded into 3 categories (ranging from 1 to 3) except the item considering participation in organized sports activities, with which a 2-point scale was used. From 2001 to 2011, all the answers to the questions were rated via a 3-point scale (ranging from 1 to 3). The specific questions from 1992 to 2011 were the following: 1) How much breathlessness and sweating do you experience when you engage in physical activity and sport? 2) How often do you engage in rigorous physical activity? 3) How many hours per week do you engage in rigorous physical activity? 4) How much time do you usually spend in a physical activity session? 5) Do you participate in organized physical activity?.

A sum score (physical activity index) of question responses was computed for each participant each study year (1980-2011), and higher scores reflected higher levels of physical activity. Previous reports have denoted that the test-retest estimates for physical activity have a good reliability over time (ICC's >0.70) (Telama et al., 2005; Yang et al., 2017). The predictive validity tests performed within 3-year intervals from 1980 to 1992 have demonstrated tracking (stability) of physical activity over time (Telama et al., 2005). Recent study has also given support for these findings by indicating that the stability of physical activity is moderate or high from youth to adult age (Telama et al., 2014). Supportive evidence of physical activity indices' construct validity has also been found (Telama et al. 2005). These results are in agreement with previous literature demonstrating that self-reports of physical activity are correlated with objective assessments of physical activity (Mansikkaniemi et al., 2012; Tudor-Locke et al., 2004). Based on the evidence, physical activity measure has been considered reliable and valid (1980-2011) (Telama et al., 2005; Telama et al., 2014).

3.2.3 Participants' sedentary behaviors (Study I)

Participants' sedentary behaviors were examined by inquiring how much time per day they spent watching TV (Helajärvi et al., 2014). In 2001 and 2007, participants self-reported how many hours

on average per day they spent viewing TV. Self-reported TV viewing in 2011 was assessed separately for weekdays and weekends in minutes, and weighted average of weekday and weekend responses was thereafter calculated [(5 × weekday + 2 × weekend)/7]. The responses were converted into 1-hour increments. Thereafter, mean scores were computed for each participant each year (Helajärvi et al., 2013; Yang et al., 2017). The stability of TV viewing has shown to range from moderate to high during adulthood (Yang et al., 2017).

3.2.4 Parents' physical activity (Study II)

Parents' physical activity was studied by surveying the regularity of their physical activity during leisure-time in 1980 (Yang et al., 1996; Yang et al., 2000). Parents self-reported their physical activity using a 3-point scale, and higher scores represented higher levels of physical activity. The information was collected separately from subjects' fathers and mothers. Parents were requested to select one of the following alternatives which best describes their way of spending their free time: 1 = No physical activity: In my leisure-time I mostly read, watch TV, listen to radio, go to movies, go to restaurant, meet my friends or do activities that do not physically strain me; 2 = Some physical activity: I participate in sports/ physical activities every now and then, or I am physically active in other hobbies such as fishing, hunting, gardening or outdoor recreation; 3 = Regular physical activity: I participate regularly or quite regularly in sports/ physical activities such as running, cross-country skiing, cycling, ball games, swimming, gymnastics or strength training.

Parents' physical activity has been studied with single questions in previous substudies performed within Cardiovascular Risk in Young Finns study (Yang et al., 1996; Yang et al., 2000). Short instruments have long been used in population surveys to assess health-related factors due their consiceness (Bowling, 2005). Literature has also demonstrated high levels of reliability, as well as construct and predictive validity of single-item measures (Bowling, 2005).

3.2.5 Beck Depression Inventory (BDI-II) (Studies III and IV)

Participants' depressive symptoms were assessed in 2012 when they were aged from 35 to 50. Beck Depression Inventory II (BDI-II) (Beck et al., 1996), consisting of 21 symptoms with a severity range from 0 (no symptoms) to 3 (severe level of depressive symptoms), was applied. A sum score of all items was calculated for each subject, and no missing items were allowed. The reliability estimate (Cronbach's α) was >0.90 for the depressive symptom scores. BDI-II has shown to be a

valid instrument (Beck et al., 1996; Storch et al., 2004; Wang et al., 2013), and it has been considered as an acknowledged standard in assessing depressive mood (Beck et al., 1996; Storch et al., 2004; Wang et al., 2013; Beck et al., 2004). It is applicable in clinical and nonclinical study contexts, including within general populations (Beck et al., 1996; Storch et al., 2004; Wang et al., 2013; Beck et al., 2004). BDI-II correlates highly with the earlier versions of the questionnaire, including modified BDI (Beck et al., 1996; Want et al., 2013), which has also been considered as a valid measure for studying depressive symptoms in general populations (Rosenström et al., 2012b). Additionally, BDI-II correlates well with other widely used instruments for depression (Wang et al., 2013), and it has shown to be a useful screening tool for potential depressed cases (Beck et al., 1996; Wang et al., 2013).

3.2.6 Questions regarding psychological well-being (Study IV)

The psychological survey in the STRIP study contained individual questions and a questionnaire (BDI-II). All questions were coded as dichotomized variables based on statistical and practical considerations (Farrington & Loeber, 2000), whereby a higher value represented a higher risk for adverse psychological outcomes. Participants' life satisfaction (Huebner, 2004) was studied using a single question, where zero represented high satisfaction (somewhat satisfied/very satisfied with life) and one represented low satisfaction (somewhat unsatisfied/very unsatisfied). Subjects' self-rated health (Manderbacka et al., 1999) was studied by asking subjects to evaluate their health in comparison to others of the same age, where zero indicated slightly better/a lot better and one represented slightly worse/a lot worse. Experiences of stress were studied (Steptoe & Kivimäki, 2013; Elo et al., 2003) through a single question, where zero represented not experiencing stress and one indicated experiencing stress. The consequences of experiencing stress, such as absences from school or work due to psychological reasons, were also evaluated. Within this question, zero represented never being absent and one represented being absent. The use of psychological healthcare services was also studied through a single item, where zero represented no use and one indicated having used such services.

3.2.7 Covariates (Studies I-IV)

In the study I, participants' parents' physical activity (1980) was assessed with the following question: "How much do you engage in physical activity per week?" (1 = every day, 2 = 2–6 times a

week, 3 = once a week, 4 = 2–3 times a month, 5 = about once a month, and 6 = not at all). Parents' socioeconomic status was determined by assessing their educational and occupational levels. The educational levels were categorized as (1) low (comprehensive school); (2) intermediate (high school or vocational school); and (3) high (college/university). The occupational levels were classified as (1) manual (e.g., builders, metal workers, cleaners, and nannies); (2) lower non-manual (e.g., civil servants, specialized workers and skilled workers); and (3) upper non-manual (e.g., administrators, managers and academics) based on the Central Statistical Office of Finland's criteria. School performance was evaluated at participants' age of 12 years using grade point averages (GPA) of all school subjects, ranging from 4 (poor) to 10 (excellent).

In the Study II, the analyses were controlled for the possible cohort effects (Hakulinen et al., 2013). Subjects' childhood living area (1=city center, 2=suburb, 3=rural community, 4=dispersed settlement area) was also adjusted for in the analyses (Bauman et al., 2012), as well as parents' cohabiting through offspring's youth (1=cohabiting, 2=living separately) (Hull et al., 2010). Previous study found no difference between being married or cohabiting on physical activity (Hull et al., 2010). As people usually cohabit prior getting married, these constructs may also overlap to some degree (Hull et al., 2010). Participants' parents' education and income levels (1980) were used as indicators of socioeconomic position in participants' childhood (Galobardes et al., 2006). Parents' educational information was obtained from mothers' and fathers' [(1= less than 9 years (low), 2= 9-12 years (average), 3=over 12 years (high)]. If parents' educational levels differed, we used information from the parent with the higher educational status. If educational information was available for only one parent, family's educational status was defined using his/ her educational information. Family's income level was determined via an 8-point scale [(1=<15 000 marks (2755 dollars), 8=>100 000 marks (18370 dollars)].

In addition, the analyses were controlled for participants' age and body mass index (Bauman et al., 2012). Weight and height were measured, and body mass index was calculated based on these information (kg/m^2). Participants' socioeconomic status (2007) (Galobardes et al., 2006) was also assessed via two indices; education was determined via a 3-category scale [1=comprehensive school (low), 2=secondary school (average), 3=academic level (high)], and income level with an 8-point scale [1=<10 000 euros (10 924 dollars), 8=>70 000 euros (76467 dollars)]. Participants' food consumption was studied using a 131-item food frequency questionnaire, and intakes of favorable (whole grains, fish, fruits, vegetables and nuts/ seeds) and unfavorable (red and processed meat, sweets, sugar-sweetened beverages and fried potatoes) foods were assessed to generate a diet score, with higher scores reflecting healthier diets (Nettleton

et al., 2013). Participants' alcohol use was studied by requesting them to report their consumption of 1/3 l cans or bottles of beer, glasses (12 cl) of wine, and 4 cl shots of liquor or strong alcohol during the last week (Juonala et al., 2009). Participants' smoking status (Bauman et al., 2012) was assessed via a 5-category scale (1=smokes a cigarette per day or more, 2=smokes once in a week, 3=smokes less than once in a week, 4=has quitted smoking, 5=has never smoked). Moreover, social support (2007) was studied via a 12-question inventory using a 5-point scale (Zimet, 1988) and a mean score of the items was computed for each participant.

Childhood, adulthood and general (age, sex and body mass index) covariates were adjusted for in the Study III (e.g., Mirowsky, 1996; Dodge, 2003; Galobardes et al., 2006; Beck et al., 1961; Luppino et al., 2010; Allgöwer et al., 2001). Participants' negative emotionality (Dodge, 2003) was reported by the primary caretaker via six questions representing participants' behavior in childhood (e.g., "The child hits/kicks other children "accidentally"), on a scale from 1 (true) to 2 (not true), and average of the items was calculated for each subject. As some of the subjects were adolescents in 1980, their caretakers responded this question retrospectively. Symptoms of participants' adulthood depression were assessed in 1992, 1997, 2001 and 2007 via a modified version of Beck Depression Inventory, referred to as modified BDI (Beck et al., 1961). Items of the measure were rated in a 5-point scale, and average of the items was computed each year for each subject. Participants' and their parents' socioeconomic status, social support and smoking status were also adjusted for in this examination, and the variables were calculated similarly as in the Study II.

In the Study IV, socioeconomic factors were adjusted for in the analyses (Galobardes et al., 2006). These included the educational level attained by participants' mothers and fathers at the child's age of 13 months, which was determined using the 3-category classification described above (Study II). Parents' educational status assessed in 2006 was also examined, rated along with the same three-point scale. Parental income in 2006 was studied using a five-point scale, (1=less than €2,000 per month, 2= €2,001 to €4,000 per month, 3= €4,001 to €6,000 per month, 4= €6,001 to €8,000 per month, and 5= more than €8,000 per month). Furthermore, participants' current educational status was adjusted for in the analyses using the three-point scale described above (Study II).

3.3 Statistical methods

In the Study I, correlation analyses were first performed to assess the associations between childhood temperamental activity, physical activity and TV viewing in participants' different ages. Thereafter, linear growth curve modeling within a multilevel context was used in studying temperamental activity's association with physical activity and sedentary behaviors. Two discrete periods of physical activity in childhood and youth (1980, 1983, 1986 and 1989) and adulthood (2001, 2007 and 2011) were studied, as well as TV viewing during participants' adult age (2001, 2007 and 2011). The associations were thereafter further tested via adjusting the models for covariates. Analyses were conducted using the statistical software Mplus (Version 7).

In the studies II-III, physical activity questionnaires for children and adolescents (1980-1989), and adults (1992-2011), differed slightly in terms of their content. To use the variables in a longitudinal design, a confirmatory factor model was used to study whether the physical activity indices comprising of five indicator variables had measurement and structural invariance over time from childhood to adulthood (Vanderberg & Lance, 2000; Beauducel & Herzberg, 2006). Weighted least squares means and variance adjusted (WLSMV) estimation was applied for these analyses (Beauducel & Herzberg, 2006; Muthén & Muthén, 1998-2010). The goodness of fit for scalar invariance was assessed with comparative fit index (CFI), Tucker-Lewis index (TLI), and root-mean square error of approximation index (RMSEA) (Cheung & Rensvold, 2002). The analyses were conducted using Mplus (version 7.1). The standardized factor scores derived from the confirmatory model are estimated values for the true latent scores, and likely to provide more precise information than the original indices. Consequently, the factor scores were applied in subsequent analyses. Prior this, correlations between the estimated factor scores and the (original) physical activity indices were studied.

In the study II, the cross-sectional and longitudinal associations between parents' physical activity and their children's activity were first studied with linear regression models. The potential birth cohort effects were controlled for in these, as well as in subsequent analyses. Due to the possible multiple testing problem, Bonferroni-corrected p-values ($p<0.003$) were applied in designating significant associations. Thereafter, the relations between parents' physical activity and the potential changes in their children's physical activity levels from childhood to adulthood were studied using linear mixed models (Hox & Roberts, 2011; Lott & James, 2013). Maximum likelihood method (ML) was utilized as an estimation technique for these models. The main effects of father's and mother's physical activity, child's age, as well as their interactions (father's /

mother's physical activity x child's age) on child's physical activity were first studied. In the case of significant interactions, we studied whether the associations differed by child's sex by assessing the 3-way interactions (father's/ mother's physical activity x child's age x child's sex). In the case of significant interactions, we examined whether parents' physical activity (father's/ mother's physical activity x child's age) related differently with females' and males' physical activity. Thereafter, the associations were further tested via controlling the models for covariates. The analyses were conducted via IBM SPSS (version 21).

In the study III, physical activity factor scores derived from the invariance examination described above (see pages 32-33) were used in all analyses. Latent Class Growth Analysis (LCGA) was applied to explore the trajectories of physical activity from childhood to adulthood. LCGA captures information about developmental processes at inter- and intraindividual levels, detecting subpopulations or -groups with distinct growth curves (Muthén & Muthén, 2000; Muthén, 2002; Jung & Wickrama, 2008). Designating the number of subgroups for physical activity was based on Akaike's Information Criterion (AIC) (Vrieze, 2012). Moreover, the determination of the groups was based on classification quality evaluations, and practical considerations (e.g., Jung & Wickrama, 2008). Within the LCGA model, the average temporal trajectories in the physical activity groups were analysed with regression equations, in which both the linear and quadratic terms were estimated for the independent variable (time).

The associations between physical activity factor scores and depressive symptoms were first assessed cross-sectionally and longitudinally applying linear regression analyses. Due to the potential multiple testing problem, Bonferroni-corrected p-values ($p < 0.003$) were used in designating the significant associations. Thereafter, associations between the physical-activity trajectories and depressive symptoms determined in 2012 were assessed with analyses of variance (ANOVA), and post-hoc tests were also conducted (Bonferroni's method). In addition, the longitudinal associations between participants' adulthood physical activity (2007) and depressive symptoms (2012) were examined with linear regression. Due to the number of missing values, the variance analyses and regression analyses in which adulthood physical activity (2007) was used as an independent variable were conducted in another dataset which was imputed using the expectation-maximization (EM) algorithm (Dempster ym., 1977). Analyses were carried out using Mplus (version 7.1 and 7.2) and IBM SPSS (version 21), and Stata (version 13).

In the study IV, binary logistic regression analyses were applied to examine whether the intervention and control groups differed in terms of indicators of psychological well-being. The logistic regression analyses were controlled for sex and socioeconomic status, and also the

interaction effects between groups and socioeconomic status on psychological well-being indicators were examined. All analyses were conducted within IBM SPSS (version 18). P-values of < 0.05 were regarded as statistically significant in each of the four studies excluding the tests in which Bonferroni-adjusted significance levels were applied.

4 RESULTS

4.1 Childhood temperament and the development of physical activity (Study I)

Table 1. Descriptives of the sample (for males N=575-645; for females N=585-652).

Variables	3- and 6-year old children (1980)				9- and 12-year old children (1980)			
	Males (N = 575)		Females (N = 585)		Males (N = 645)		Females (N= 652)	
	N	M ± SD	N	M ± SD	N	M ± SD	N	M ± SD
Temperamental activity	564	2.20±0.68	579	2.09 ± 0.59	634	2.09 ± 0.59	638	1.99 ± 0.59
Parents' physical activity (1980)	537	2.17±0.65	546	2.16 ± 0.65	546	2.11 ± 0.64	575	2.11 ± 0.68
Parents' socioeconomic status (1980)	570	1.44±0.66	578	1.43 ± 0.68	632	1.35 ± 0.60	640	1.37 ± 0.61
School performance (GPA) (1980)[a]	446	7.77±0.71	470	8.16 ± 0.66	594	7.48 ± 0.72	589	7.97 ± 0.69
Physical activity in 1980[b]	575	16.54±2.53	579	15.72 ± 2.35	628	9.90 ± 1.62	631	9.03 ± 1.54
Physical activity in 1983	246	9.90±1.52	259	8.80 ± 1.27	542	9.67 ± 1.98	557	8.76 ± 1.66
Physical activity in 1986	471	9.94±1.74	481	8.96 ± 1.51	423	9.02 ± 2.16	475	8.40 ± 1.88
Physical activity in 1989	440	9.75±2.08	474	8.95 ± 1.80	401	8.37 ± 2.34	520	8.24 ± 1.90
Physical activity in 2001	347	9.31±2.28	441	8.99 ± 1.81	393	8.91 ± 2.11	470	8.80 ± 1.84
Physical activity in 2007	302	8.86±2.06	376	8.99 ± 1.73	336	8.71 ± 1.87	422	8.82 ± 1.79
Physical activity in 2011	258	9.06±1.97	326	9.19 ± 1.89	299	8.85 ± 1.90	371	9.19 ± 1.96
TV viewing in 2001	363	2.15±1.21	461	2.10 ± 1.22	415	2.13 ± 1.12	503	1.92 ± 1.05
TV viewing in 2007	308	1.86±1.24	381	1.68 ± 1.15	348	1.88 ± 1.07	427	1.73 ± 1.03
TV viewing in 2011	263	1.80±1.27	329	1.61 ± 1.06	307	1.98 ± 1.12	380	1.72 ± 1.06

M, mean; *SD,* standard deviation.
[a] GPA reflects children's grade point average at age of 12.
[b] Among 3- and 6-year old children, physical activity was assessed with maternal ratings.

The descriptives of the study are presented in Table 1. Correlation analyses demonstrated some positive associations between temperamental activity and physical activity in participants' childhood, but as the children aged the direction of the associations turned into negative ($p<0.05$) or disappeared ($p>0.05$). Furthermore, some positive associations between temperamental activity and TV viewing in adulthood were found ($p<0.05$). Table 2 presents the estimates reflecting whether temperamental activity associated with the level and change (slope) of participants' physical activity during childhood and youth (1980-1989). Within females, whose temperamental activity

was assessed at ages 3 and 6, temperamental activity was negatively associated with changes in physical activity during youth (1980-1989). Within both sexes, whose temperamental activity was assessed at ages 9 and 12, temperamental activity was positively associated with the levels of physical activity in youth. Futhermore, males' temperamental activity assessed at ages 9 and 12 was negatively associated with the changes of physical activity in youth. These associations remained significant after controlling for participants' school performance at age 12, parents' physical activity, and parents' socioeconomic status.

Table 2. Childhood temperamental activity (1980) predicting the level and slope of physical activity in childhood, youth and adulthood (1980-2011).

	Physical activity in childhood and youth (1980-1989)[a]						Physical activity in adulthood (2001-2011)					
	Level			Slope			Level			Slope		
	b	SE	p	b	SE	p	b	SE	p	b	SE	p
3- and 6-year old children												
Males												
Step 1[b]	0.05	0.14	0.740	0.02	0.03	0.606	-0.33	0.17	0.050	0.01	0.02	0.400
Step 2[c]	0.07	0.14	0.618	0.02	0.03	0.474	-0.27	0.17	0.106	0.01	0.02	0.417
Step 3[d]							-0.26	0.17	0.123	0.01	0.02	0.570
Females												
Step 1[b]	0.09	0.10	0.392	-0.07	0.03	0.009	-0.12	0.14	0.401	0.01	0.02	0.432
Step 2[c]	0.09	0.10	0.365	-0.05	0.03	0.047	-0.10	0.13	0.477	0.02	0.02	0.403
Step 3[d]							-0.07	0.14	0.610	0.01	0.02	0.422
9- and 12-year old children												
Males												
Step 1[b]	0.28	0.12	0.022	-0.05	0.02	0.015	-0.36	0.18	0.045	0.03	0.02	0.138
Step 2[c]	0.28	0.12	0.017	-0.04	0.02	0.040	-0.28	0.17	0.101	0.03	0.02	0.143
Step 3[d]							-0.37	0.16	0.019	0.04	0.02	0.076
Females												
Step 1[b]	0.19	0.10	0.068	-0.01	0.02	0.680	-0.14	0.14	0.335	0.00	0.02	0.913
Step 2[c]	0.20	0.10	0.046	0.00	0.02	0.950	-0.11	0.14	0.455	0.00	0.02	0.932
Step 3[d]							-0.13	0.14	0.326	0.00	0.02	0.935

b, unstandardized regression coefficient; SE, standard error; p, p-value.
aWithin 3- and 6-year-old children, the models were fitted for time interval 1983-1989.
[b]An unadjusted model.
[c]A model was adjusted for GPA, parents' physical activity, and parents' socioeconomic status.
[d]A model was adjusted for GPA, parents' physical activity, parents' socioeconomic status, and for participants' physical activity in 1980.

Temperamental activity assessed at ages 9 to 12 was negatively associated with the physical activity levels in adulthood (2001-2011) in males (Table 2). After adjusting for the school performance, parents' physical activity, and parents' socioeconomic status, the associations disappeared. After further adjustment for participants' baseline physical activity, the association turned into significant.

Table 3. Childhood temperamental activity (1980) predicting the level and slope of TV viewing in adulthood (2001-2011).

	Level			Slope		
	b	SE	p	b	SE	p
3- and 6-year-old children						
Males						
Step 1[a]	0.17	0.08	0.036	-0.01	0.01	0.292
Step 2[b]	0.17	0.08	0.034	-0.01	0.01	0.209
Step 3[c]	0.19	0.08	0.019	-0.01	0.01	0.154
Females						
Step 1[a]	0.01	0.09	0.918	0.00	0.01	0.786
Step 2[b]	-0.04	0.09	0.672	0.00	0.01	0.995
Step 3[c]	-0.06	0.09	0.537	0.00	0.01	0.891
9-and 12-year-old children						
Males						
Step 1[a]	0.02	0.10	0.804	0.01	0.01	0.476
Step 2[b]	-0.02	0.10	0.874	0.01	0.01	0.546
Step 3[c]	-0.04	0.10	0.720	0.01	0.01	0.477
Females						
Step 1[a]	0.17	0.08	0.029	-0.01	0.01	0.582
Step 2[b]	0.11	0.08	0.168	-0.01	0.01	0.615
Step 3[c]	0.12	0.08	0.147	0.00	0.01	0.636

[a]An unadjusted model.
[b]A model was adjusted for school performance at age of 12, parents' physical activity and parents' socioeconomic status.
[c]A model was adjusted for school performance at age of 12, parents' physical activity and parents' socioeconomic status, and for participants' physical activity in 1980.

Temperamental activity assessed at children's ages 3 and 6 was associated with higher levels of TV viewing (2001-2011) in males, independent of the covariate controls (Table 3). Temperamental activity assessed at ages 9 and 12 was associated with higher levels of TV viewing in females. The association attenuated after adjusting for covariates.

4.2 Parents' physical activity and the development of offspring's physical activity (Study II)

Descriptives of the sample are presented in Table 4. The scalar invariance model for physical activity did not indicate strong factorial invariance across time, but the fit for partial scalar invariance model was acceptable (CFI=0.90, TLI=0.90, RMSEA=0.047), given partial invariance of the thresholds. For RMSEA, values <0.05 demonstrate a close model fit, and CFI and TLI values close to 0.90 give evidence for an adequate fit (Cheung & Rensvold, 2002). The deviance from full measurement invariance was due to a one item, which concerned the participation in organized

sports (assessed from 1980 to 2011). Within the question, the measurements were invariant through childhood and adolescence, but a minor deviation (although significant, $p<0.05$) from full invariance was detected in adulthood. Since the partial scalar invariance model was regarded acceptable, factor scores were predicted for each participant to be used in subsequent analyses (Table 5). The estimated factor scores correlated highly with physical activity indices from subjects' childhood to adult age (1980-2011), coefficients ranging from 0.95 to 0.97.

Table 4. Descriptives of the sample (for females, N=461-1832; for males, N=438-1764).

Variables	Females			Males		
	N	M ± SD/ (% of total N)	Range	N	M ± SD/ (% of total N)	Range
Covariates						
Birth cohort (1980)	1832	10.53±4.99	3-18	1764	10.36±4.99	3-18
Family's living area (1980)						
City center	180	9.8%		187	10.6%	
Suburb	672	36.8%		654	37.2%	
Rural community	533	29.2%		486	27.7%	
Dispersed settlement area	443	24.2%		429	24.4%	
Parents' cohabiting status (1980)						
Cohabiting	1571	85.9%		1487	84.5%	
Living separately	258	14.1%		273	15.5%	
Parents' cohabiting status (1983)						
Cohabiting	1298	89.5%		1198	87.1%	
Living separately	153	10.5%		177	12.9%	
Parents' cohabiting status (1986)						
Cohabiting	669	88.5%		636	86.8%	
Living separately	87	11.5%		97	13.2%	
Parents' cohabiting status (1989)						
Cohabiting	397	86.1%		376	85.8%	
Living separately	64	13.9%		62	14.2%	
Parents' education (1980)						
Low	638	35.4%		590	33.9%	
Average	721	40.0%		707	40.7%	
High	442	24.5%		442	25.4%	
Parents' income (1980)	1752	4.78±1.96	1-8	1701	4.81±1.92	1-8
Subject's age	1832	31.58±11.83	9-49	1764	31.58±11.83	9-49
Subject's body mass index (2007)	1183	25.38±5.06	16.56-58.82	987	26.75±4.24	17.54-49.35
Subject's education (2007)						
Low	306	28.4%		407	43.0%	
Average	246	22.9%		130	13.7%	
High	524	48.7%		409	43.2%	
Subject's income (2007)	1173	3.05±1.35	1-8	973	4.03±1.62	1-8
Subject's diet (2007)	1105	15.01±3.73	3-26	867	11.87±3.74	2-21
Subject's alcohol use (2007)	1212	0.55±0.72	0-5.43	993	1.40±1.84	0-28.57
Subject's smoking status	1225	4.00±1.44	1-5	999	3.57±1.60	1-5
Subject's social support (2007)	1211	4.33±0.71	1.42-5.00	844	3.89±0.85	1.08-5.00
Independent variables (1980)						
Mother's physical activity						
No physical activity	550	30.9%		508	29.9%	
Some physical activity	939	52.7%		913	53.7%	
Regular physical activity	292	16.4%		279	16.4%	
Father's physical activity						
No physical activity	361	22.5%		351	23.1%	
Some physical activity	899	56.2%		861	56.7%	
Regular physical activity	341	21.3%		307	20.2%	

Dependent variables[a,b]

Physical activity 1980	1133	8.60±1.63 (61.8%)[c]	5-14	1091	9.52 ±1.91 (61.9%)	5-14
Physical activity 1983	1093	8.60±1.65 (59.7%)	5-14	1023	9.49±2.00 (58.0%)	5-14
Physical activity 1986	1223	8.54±1.79 (66.8%)	5-14	1097	9.31±2.16 (62.2%)	5-14
Physical activity 1989	1443	8.43±1.88 (78.8%)	5-14	1176	8.88±2.33 (66.7%)	5-14
Physical activity 1992	1210	8.83±1.70 (66.0%)	5-14	982	9.40±2.13 (55.7%)	5-14
Physical activity 2001	1345	8.79±1.79 (73.4%)	5-15	1097	8.94±2.15 (62.2%)	5-15
Physical activity 2007	1200	8.86±1.71 (65.5%)	5-15	966	8.76±1.93 (54.8%)	5-15
Physical activity 2011	1064	9.11±1.87 (58.1%)	5-15	846	8.91±1.89 (48.0%)	5-15

M, mean, SD, standard deviation.
[a]Physical activity indices ≤ 7 represent low, >7 to 10< moderate, and ≥10 high levels of physical activity
[b]Factor scores, which were predicted from the original physical activity indices (1980-2011), were used in all analyses (see Table 5). In 1980, participants were aged 9-18; in 1983, 9-21; in 1986, 9-24; in 1989, 12-27; in 1992, 15-30; in 2001, 24-39; in 2007, 30-45; in 2011, 34-49. Subjects, who were not able to self-report their physical activity levels in 1980 (3 and 6 year-olds) were included to the study at their age of 9 (during the years 1983 and 1986).
[c]Proportion of subjects who were included to the Cardiovascular Risk in Young Finns Study (females n=1832, males n=1764) in 1980.

Table 5. Descriptives[a] of the physical activity factor scores by age (for females, N=275-1544; for males, N=257-1488).

Subject's age	Females			Males		
	N	M ± SD	Range	N	M ± SD	Range
9	896	0.10±0.40	-1.09 to 1.50	879	0.36±0.46	-1.27 to 1.67
12	1225	0.11±0.47	-1.30 to 1.74	1201	0.37±0.52	-1.61 to 1.83
15	1539	-0.01±0.54	-1.56 to 1.88	1488	0.20±0.60	-1.79 to 1.95
18	1544	-0.13±0.55	-1.63 to 1.84	1463	0.04±0.62	-1.61 to 2.04
21	1246	-0.15±0.52	-1.67 to 1.87	1189	-0.05±0.63	-1.73 to 1.91
24	1198	-0.10±0.53	-1.76 to 1.96	1148	-0.03±0.64	-1.75 to 1.65
27	892	-0.11±0.54	-1.84 to 1.60	818	-0.04±0.61	-1.69 to 1.86
30	878	-0.06±0.54	-2.00 to 1.63	862	-0.01±0.64	-1.74 to 1.66
33	627	-0.02±0.52	-1.68 to 2.08	596	-0.03±0.56	-1.76 to 1.49
34	275	0.07±0.50	-1.61 to 1.42	282	0.11±0.61	-1.74 to 1.50
36	637	-0.08±0.52	-1.90 to 1.75	610	-0.04±0.58	-1.80 to 1.63
37	298	-0.00±0.54	-1.76 to 2.00	274	0.01±0.55	-1.57 to 1.25
39	609	-0.07±0.54	-1.66 to 1.45	579	-0.11±0.58	-1.87 to 1.53
40	323	-0.03±0.56	-1.89 to 1.58	323	0.01±0.59	-1.77 to 1.41
42	314	-0.08±0.52	-1.92 to 1.87	287	-0.07±0.61	-1.87 to 1.79
43	329	-0.01±0.55	-1.67 to 1.71	322	-0.12±0.58	-1.91 to 1.39
45	280	-0.10±0.56	-1.75 to 1.82	257	-0.09±0.64	-1.88 to 2.25
46	314	-0.08±0.53	-1.91 to 1.78	287	-0.06±0.59	-1.86 to 1.34
49	280	-0.07±0.59	-1.83 to 1.51	257	-0.09±0.64	-1.96 to 2.13

[a]The values are standardized factor scores, with a mean of 0 and a standard deviation of 1.

The linear regression analyses showed that mothers' and fathers' physical activity was systematically and favorably associated with their children's physical activity until offspring's age of 24 (Table 6). Furthermore, few associations were found in participants' middle adulthood (Table 6). Fathers' physical activity patterns had relatively far-reaching effects on males' physical activity until their age of 37, and mothers' physical activity on females' physical activity until their age of 33 (Table 6).

Table 6. Mother's and father's physical activity (1980) predicting females' and males' physical activity at different ages (1980-2011).[a]

	Mother's physical activity				Father's physical activity			
	Females (N=266-1503)		Males (N=245-1437)		Females (N=230-1358)		Males (N=203-1299)	
Subject's age	b	p[b]	b	p	b	p	b	p
9	0.10	<0.001	0.10	<0.001	0.11	<0.001	0.14	<0.001
12	0.12	<0.001	0.08	0.001	0.14	<0.001	0.17	<0.001
15	0.13	<0.001	0.08	0.001	0.12	<0.001	0.19	<0.001
18	0.13	<0.001	0.06	0.009	0.11	<0.001	0.20	<0.001
21	0.12	<0.001	0.08	0.005	0.10	<0.001	0.20	<0.001
24	0.10	<0.001	0.10	<0.001	0.07	0.005	0.16	<0.001
27	0.08	0.002	0.08	0.014	0.05	0.093	0.15	<0.001
30	0.07	0.007	0.10	0.002	0.08	0.003	0.20	<0.001
33	0.09	0.005	0.05	0.128	0.04	0.293	0.13	0.001
34	-0.02	0.642	0.13	0.016	-0.00	0.935	0.17	0.004
36	0.08	0.007	0.04	0.245	0.10	0.004	0.17	<0.001
37	0.10	0.036	0.05	0.310	0.05	0.360	0.11	0.041
39	0.09	0.007	0.05	0.183	0.07	0.064	0.08	0.055
40	0.06	0.204	0.04	0.482	0.13	0.007	0.15	0.005
42	0.05	0.247	0.03	0.537	0.05	0.354	0.18	0.002
43	0.09	0.053	0.05	0.366	0.09	0.074	0.06	0.279
45	0.07	0.148	0.09	0.123	0.07	0.226	0.13	0.057
46	0.01	0.808	0.08	0.120	0.01	0.902	0.21	<0.001
49	0.03	0.529	0.08	0.174	0.05	0.356	0.11	0.118

[a]The analyses were controlled for birth cohort effects (assessed in 1980).
[b]Bonferroni-corrected p-values (α=0.05/19, p<0.003) were used in determining significant results.

When the main effects were studied via linear mixed models without the inclusion of the interaction term, mothers' physical activity (β=0.09, SE=0.01, p<0.001, 95%CI: 0.07 to 0.11) and participants' age predicted the subjects' physical activity (β=-0.00, SE=0.00, p<0.001, 95%CI: -0.00 to -0.00). When the main effects were examined without the inclusion of the interaction term, fathers' physical activity (β=0.12, SE=0.01, p<0.001, 95%CI: 0.10 to 0.15) and participants' age were significant predictors for subjects' physical activity (β=-0.00, SE=0.00, p<0.001, 95%CI: -0.00 to -0.00).

After studying the main effects, interaction terms were added to the linear mixed models. The results from the first 2-way interaction analysis (mother's physical activity x child's age) showed that the favorable impact of mothers' physical activity on children's activity decreased along with time (β=-0.00, p<0.001, R^2=0.06) (Table 7). When the 3-way interactions (mother's physical activity x age x sex) were examined, mothers' physical activity had distinct effects on females' and males' physical activity (β=0.00, p=0.00, R^2=0.07) (Table 7). When the 2-way

interactions (mother's physical activity x child's age) were assessed separately in females and males, mothers' activity associated favorably with both groups' physical activity, and the effect decreased along with time (in females, β=-0.00, $p<0.001$, R^2=0.04; in males, β=-0.001, $p=0.03$, R^2=0.10) (Table 7).

Table 7. Mothers' and fathers' physical activity (1980), participants' age and sex as predictors for participants' physical activity from childhood to middle age (from 1980 to 2011).[a]

Independent variables	β	SE	p	95%CI	R^2
Model 1					
Mothers' physical activity (1980)	0.14	0.01	<0.001	0.11 to 0.17	
Subjects' age	0.00	0.00	0.573	-0.00 to 0.00	
Mothers' physical activity x age	-0.00	0.00	<0.001	-0.00 to -0.00	0.06
Model 2					
Fathers' physical activity (1980)	0.17	0.02	<0.001	0.14 to 0.20	
Subjects' age	-0.00	0.00	0.906	-0.00 to 0.00	
Fathers' physical activity x age	-0.00	0.00	<0.001	-0.00 to -0.00	0.18
Model 3					
Mothers' physical activity (1980)	0.17	0.02	<0.001	0.14 to 0.21	
Subjects' age	0.01	0.00	<0.001	0.00 to 0.01	
Subjects' sex (female vs. male)	0.45	0.05	<0.001	0.35 to 0.56	
Age x sex	-0.01	0.00	<0.001	-0.01 to -0.01	
Mothers' physical activity x age	-0.00	0.00	<0.001	-0.00 to -0.00	
Mothers' physical activity x sex	-0.07	0.03	0.012	-0.12 to -0.02	
Mothers' physical activity x age x sex	0.00	0.00	0.002	0.00 to 0.00	0.07
Model 4					
Fathers' physical activity (1980)	0.15	0.02	<0.001	0.11 to 0.19	
Subjects' age	0.01	0.00	<0.001	0.00 to 0.01	
Subjects' sex	0.20	0.06	0.001	0.08 to 0.32	
Age x sex	-0.01	0.00	<0.001	-0.01 to -0.01	
Fathers' physical activity x age	-0.00	0.00	<0.001	-0.00 to -0.00	
Fathers' physical activity x sex	0.06	0.03	0.043	0.00 to 0.12	
Fathers' physical activity x age x sex	0.00	0.00	0.339	-0.00 to 0.00	0.19
Model 5 (females)					
Mothers' physical activity (1980)	0.17	0.02	<0.001	0.14 to 0.21	
Subjects' age	0.01	0.00	<0.001	0.00 to 0.01	
Mothers' physical activity x age	-0.00	0.00	<0.001	-0.00 to -0.00	0.04
Model 6 (males)					
Mothers' physical activity (1980)	0.10	0.02	<0.001	0.06 to 0.15	
Subjects' age	-0.01	0.00	<0.001	-0.01 to -0.00	
Mothers' physical activity x age	-0.00	0.00	0.025	-0.00 to -0.00	0.10

β, regression estimate; CI, confidence interval; R^2, coefficient of determination.
[a]All the analyses were controlled for the birth cohort effects (assessed in 1980).

After controlling for covariates, mothers' physical activity's effect on females' activity remained significant (β=-0.01, p<0.001, R^2=0.04), as well as mothers' physical activity and males' physical

activity (β=0.01, p<0.001, R^2=0.18) (Table 8). Mothers' and females' physical activity's favorable association decreased along with time. Mothers' physical activity was positively related to males' physical activity, and the association seemed not to change with time.

When the interaction of fathers' physical activity and subjects' age on participants' physical activity was examined, the favorable effect of fathers' physical activity on children's physical activity decreased with time (β=-0.00, p<0.001, R^2=0.18) (Table 7). When the 3-way interactions (father's physical activity x age x sex) were examined, fathers' physical activity associated similarly with both sexes' physical activity (β=0.00, p=0.34, R^2=0.19) (Table 7). The association between fathers' activity and children's physical activity was independent of covariate adjustment (β=-0.00, p<0.01, R^2=0.12) (Table 8).

Table 8. Mothers' and fathers' physical activity (1980) and subjects' age as predictors for subjects' physical activity from childhood to middle age (from 1980 to 2011) adjusting for covariates.

Predictors	β	SE	p	95%CI	R^2
Model 1					
Covariates					
Birth cohort (1980)	-0.05	0.02	0.001	-0.09 to -0.02	
Living area (1980)	-0.02	0.03	0.515	-0.08 to 0.04	
Parents' cohabiting (1983)[a]	0.05	0.21	0.812	-0.36 to 0.46	
Parents' cohabiting (1986)	-0.03	0.21	0.884	-0.45 to 0.39	
Parents' cohabiting (1989)	-0.09	0.14	0.531	-0.37 to 0.19	
Parents' education (1980)	-0.04	0.04	0.301	-0.12 to 0.04	
Parents' income (1980)	0.01	0.02	0.432	-0.02 to 0.05	
Subjects' body mass index (2007)	0.00	0.01	0.720	-0.01 to 0.01	
Subjects' education (2007)	0.00	0.03	0.945	-0.06 to 0.07	
Subjects' income (2007)	0.07	0.02	<0.001	0.03 to 0.11	
Subjects' diet (2007)	0.01	0.01	0.200	-0.00 to 0.02	
Subjects' alcohol use (2007)	0.05	0.03	0.074	-0.01 to 0.11	
Subjects' smoking status (2007)	0.03	0.02	0.109	-0.01 to 0.07	
Subjects' social support (2007)	0.03	0.04	0.408	-0.04 to 0.11	
Independent variables					
Fathers' physical activity (1980)	0.21	0.05	<0.001	0.11 to 0.32	
Subjects' age	0.00	0.00	0.956	-0.01 to 0.01	
Fathers' physical activity x age	-0.00	0.00	0.009	-0.01 to -0.00	0.12
Model 2 (females)					
Covariates					
Birth cohort (1980)	-0.05	0.02	0.013	-0.08 to -0.01	
Living area (1980)	0.01	0.03	0.784	-0.05 to 0.07	
Parents' cohabiting (1983)	0.04	0.17	0.818	-0.30 to 0.38	
Parents' cohabiting (1986)	-0.03	0.20	0.891	-0.42 to 0.36	
Parents' cohabiting (1989)	0.01	0.14	0.947	-0.27 to 0.29	
Parents' education (1980)	-0.04	0.04	0.344	-0.12 to 0.04	
Parents' income (1980)	0.01	0.02	0.497	-0.02 to 0.05	
Subjects' body mass index (2007)	-0.00	0.01	0.636	-0.01 to 0.01	
Subjects' education (2007)	-0.01	0.04	0.894	-0.08 to 0.07	
Subjects' income (2007)	0.02	0.03	0.517	-0.03 to 0.07	
Subjects' diet (2007)	0.01	0.01	0.066	-0.00 to 0.03	
Subjects' alcohol use (2007)	0.11	0.04	0.003	0.04 to 0.19	
Subjects' smoking status (2007)	0.05	0.02	0.009	0.01 to 0.09	
Subjects' social support (2007)	0.05	0.04	0.219	-0.03 to 0.14	
Independent variables					
Mothers' physical activity	0.19	0.06	0.001	0.08 to 0.30	
Subjects' age	0.01	0.00	0.025	0.00 to 0.02	
Mothers' physical activity x age	-0.01	0.00	0.002	-0.01 to -0.00	0.04

Model 3 (males)

Covariates

Birth cohort (1980)	-0.06	0.03	0.063	-0.11 to 0.00	
Living area (1980)	-0.13	0.05	0.019	-0.23 to -0.02	
Parents' cohabiting (1983)	0.37	0.37	0.322	-0.37 to 1.11	
Parents' cohabiting (1986)	-0.13	0.37	0.718	-0.87 to 0.60	
Parents' cohabiting (1989)	-0.42	0.26	0.099	-0.93 to 0.08	
Parents' education (1980)	-0.02	0.07	0.737	-0.17 to 0.12	
Parents' income (1980)	0.02	0.03	0.550	-0.04 to 0.07	
Subjects' body mass index (2007)	0.01	0.01	0.363	-0.01 to 0.03	
Subjects' education (2007)	0.08	0.06	0.196	-0.04 to 0.19	
Subjects' income (2007)	0.05	0.03	0.138	-0.02 to 0.12	
Subjects' diet (2007)	0.02	0.01	0.129	-0.01 to 0.04	
Subjects' alcohol use (2007)	-0.05	0.05	0.272	-0.14 to 0.04	
Subjects' smoking status (2007)	0.02	0.03	0.513	-0.04 to 0.08	
Subjects' social support (2007)	0.06	0.06	0.354	-0.07 to 0.18	
Independent variables					
Mothers' physical activity	-0.16	0.09	0.074	-0.34 to 0.02	
Subjects' age	-0.03	0.00	<0.001	-0.04 to -0.02	
Mothers' physical activity x age	0.01	0.00	<0.001	0.00 to 0.01	0.18

[a]Parents' cohabiting in 1980 was excluded from the analyses due to multicollinearity.

4.3 Lifelong physical activity and psychological well-being (Study III)

Descriptives of the original sample are presented in Table 9. The partial scalar invariance model was considered adequate (CFI = 0.90, TLI = 0.90, and RMSEA = 0.047), given partial invariance of the threshold parameters (for details, see pages 38-39). Since the partial scalar invariance model was acceptable, factor scores were predicted for each examinee to be used in subsequent analyses (Table 10).

Table 9. Descriptives of the original sample (N=1724–3596).[a]

Variables	N	M ± SD/ %	Range
Covariates			
Age (1980)	3596	10.44 ± 4.99	3–18
Negative emotionality (1980)	3177	1.06 ± 0.11	1–2
Parental education[b](1980)	3540	1.90 ± 0.77	1–3
Parental income (1980)	3453	4.80 ± 1.94	1–8
Symptoms of depression (1992)	2330	2.14 ± 0.60	1–4.57
Symptoms of depression (1997)	2099	2.15 ± 0.67	1–4.57
Symptoms of depression (2001)	2097	2.07 ± 0.67	1–4.62
Symptoms of depression (2007)	2056	2.06 ± 0.68	1–4.67
Subject's education[c] (2007)	2022	2.11 ± 0.90	1–3
Subject's income (2007)	2146	3.50 ± 1.56	1–8
Social support (2007)	2055	4.15 ± 0.80	1.08–5.00
Body mass index (2007)	2170	26.00 ± 4.75	16.56–58.82
Smoking status (2007)	2224	3.81 ± 1.53	1–5
Physical activity indices[d]			
Physical activity (1980)	2224	9.05 ± 1.83	5–14
Physical activity (1983)	2116	9.03 ± 1.88	5–14
Physical activity (1986)	2320	8.90 ± 2.01	5–14
Physical activity (1989)	2619	8.63 ± 2.10	5–14
Physical activity (1992)	2192	9.08 ± 1.92	5–14
Physical activity (2001)	2442	8.86 ± 1.96	5–15
Physical activity (2007)	2166	8.81 ± 1.81	5–15
Physical activity (2011)	1910	9.02 ± 1.88	5–15
Physical activity trajectories			
Lightly physically active (1980-2011)	371	10.4%	
Moderately physically active (1980-2011)	3046	85.5%	
Highly physically active (1980-2011)	147	4.1%	
Dependent variable			
Symptoms of depression (BDI-II) (2012)	1724	5.04 ± 6.60	0–58

[a]The original sample size was 3596, and 1764 (49.1%) of the subjects were males and 1832 (50.9%) were females.
[b]The frequencies of parents' educational levels were the following: low, n=1228 (34.7%); average, n=1428, (40.3%); high, n=884, (25.0%).
[c]The frequencies of subjects' educational levels were the following: low, n=713, (35.3%); average, n=376, (18.6%); high, n=933 (46.1%).
[d]Physical activity indices ≤ 7 indicate low, >7 to 10 < moderate, and ≥10 high levels of physical activity. Factor scores, which were predicted from physical activity indices (1980–2011) (Table 10), were used in LCGA.

Table 10. Descriptives of the physical activity factor scores by age (N = 537-3027).[a]

Subject's age	N	M ± SD	Range
9	1775	0.23±0.45	-1.27 to 1.67
12	2426	0.23±0.51	-1.61 to 1.83
15	3027	0.09±0.58	-1.79 to 1.95
18	3007	-0.05±0.59	-1.63 to 2.04
21	2435	-0.10±0.58	-1.73 to 1.91
24	2346	-0.06±0.59	-1.76 to 1.96
27	1710	-0.08±0.57	-1.84 to 1.86
30	1740	-0.03±0.59	-2.00 to 1.66
33	1223	-0.02±0.54	-1.76 to 2.08
34	557	0.09±0.56	-1.74 to 1.50
36	1247	-0.06±0.55	-1.90 to 1.75
37	572	0.00±0.55	-1.76 to 2.00
39	1188	-0.09±0.56	-1.87 to 1.53
40	646	-0.01±0.57	-1.89 to 1.58
42	601	-0.08±0.57	-1.92 to 1.87
43	651	-0.07±0.57	-1.91 to 1.71
45	537	-0.09±0.60	-1.88 to 2.25
46	601	-0.07±0.56	-1.91 to 1.78
49	537	-0.08±0.61	-1.96 to 2.13

[a]In 1980, subjects were aged 9-18; in 1983, 9-21; in 1986, 9-24; in 1989, 12-27; in 1992, 15-30; in 2001, 24-39; in 2007, 30-45; and in 2011, 34-49.

The prerequisites of growth mixture modeling (e.g., Curran et al., 2010) were met to a satisfactory degree. LCGA gave evidence that a three-factor (group) solution was the best fitting model for the data based on AIC indices (AIC = 48915.44, 48915.39, 48901.43, 48902.85, and 48907.08 for 1, 2, 3, 4, and 5 groups, respectively; a lower AIC indicates a better model). The classification quality of the three-factor model was also acceptable based on the average probability estimates (group 1= 0.74, group 2=0.86, and group 3=0.71). Values >0.70 indicate that the group consists of participants with similar patterns of change (Andruff et al., 2009). Three trajectory groups were detected, the lightly (N=317), moderately (N=3046), and highly (N=147) physically active ones. Linear parameter estimates were found for these groups (lightly physically active group: β=-0.01, $p<0.001$; moderately physically active group: β=-0.00, $p<0.001$; highly physically active group: β=-0.00, $p<0.001$). Based on the estimated marginal means, subjects' physical activity levels remained relatively unchanged from childhood to adulthood (from the age 9 to 49) in each group, although these levels appeared to diminish minimally towards middle adulthood in all examinees. Within the lightly active participants' trajectory, the estimated physical activity factor scores ranged from -0.82 to -0.42, within moderately active ones' trajectory from -0.03 to 0.08, and within the highly active ones' trajectory from 0.62 to 0.79.

The regression analyses conducted in the original sample (N=255-1467) showed that low levels of physical activity factor scores were, in most examined ages, associated with higher levels of depressive symptoms in subjects' adulthood ($p<0.05$). Some of the associations attenuated when Bonferroni-corrected p-values ($p<0.003$) were applied (Table 11).

Table 11. Physical activity factor scores (assessed at subjects' ages from 9 to 49) as predictors of symptoms of depression (participants aged from 35 to 50).

Subject's age	b	SE	β	p	95%CI
9	−1.06	0.51	−0.07	0.040	−2.06 to −0.05
12	−1.73	0.39	−0.13	<0.001	−2.49 to −0.98
15	−1.72	0.30	−0.15	<0.001	−2.30 to −1.14
18	−1.21	0.29	−0.11	<0.001	−1.78 to −0.63
21	−1.33	0.34	−0.11	<0.001	−1.99 to −0.66
24	−1.53	0.30	−0.15	<0.001	−2.12 to −0.95
27	−1.52	0.35	−0.15	<0.001	−2.21 to −0.84
30	−0.86	0.35	−0.08	0.015	−1.56 to −0.17
33	−1.16	0.47	−0.10	0.014	−2.08 to −0.24
34	−0.51	0.51	−0.06	0.324	−1.52 to 0.50
36	−0.68	0.49	−0.06	0.161	−1.64 to 0.27
37	−0.89	0.60	−0.09	0.140	−2.07 to 0.29
39	−1.59	0.44	−0.15	<0.001	−2.46 to −0.73
40	−0.34	0.72	−0.03	0.643	−1.76 to 1.09
42	−1.96	0.60	−0.18	0.001	−3.14 to −0.79
43	−1.65	0.61	−0.16	0.007	−2.85 to −0.45
45	−1.31	0.57	−0.13	0.022	−2.44 to −0.19
46	−2.22	0.58	−0.21	<0.001	−3.35 to −1.09
49	−1.34	0.54	−0.14	0.014	−2.41 to −0.27

The variance analyses conducted in the original sample (N=1722) indicated that the physical activity trajectory groups predicted symptoms of depression [$F(2,1719 = 8.12$, $p<0.001$, adjusted $R^2= 0.01$)]. Post hoc tests showed that highly physically active group had lower levels of depressive symptoms than lightly active participants (mean difference = −3.26; $p<0.001$, 95%CI: −5.25 to −1.26). Highly physically active participants had lower levels of depression comparing to moderately active ones (mean difference = −1.92, $p= 0.02$, 95%CI: −3.66 to −0.18). Furthermore, moderately active participants had lower levels of depressive symptoms than lightly active participants (mean difference = −1.33, $p=0.02$, 95%CI: −2.48 to −0.19). After adjusting for the covariates, the associations attenuated to nonsignificance [$F(2, 631) = 2.13$, $p= 0.12$, adjusted $R^2= 0.25$]. The previous symptoms of depression measured in 1992, 1997, 2001, and 2007 attenuated the associations ($p>0.05$).

We also studied the unadjusted associations in the data with full information on all study variables (N= 648), in which case the association between the physical activity trajectories and depressive symptoms became only marginally significant [$F(2,645) = 2.76$, $p=0.06$, adjusted $R^2= 0.01$]. As the sample attrition might have affected this association (i.e., by reducing the statistical power), the analyses were also conducted in a dataset which was imputed using EM-algorithm (N= 3564-3596). This method was used as the Little's MCAR test (Little, 1988) confirmed that the data were not missing completely at random ($\chi^2=3903.02$, df=2923, $p<0.001$). In the imputed data, physical activity trajectories predicted the symptoms of depression [$F(2,3561) = 16.74$, $p<0.001$, adjusted $R^2= 0.01$]. Post hoc tests showed that highly physically active group had lower levels of depressive symptoms than lightly active participants (mean difference = −2.74; $p<0.001$, 95%CI: −3.91 to −1.56) (Figure 2). Highly physically active group had lower levels of depressive symptoms in comparison to moderately active one (mean difference = −1.59, $p=0.001$, 95%CI: −2.60 to −0.57) (Figure 2). Also moderately active participants had lower levels of depressive symptoms than lightly active ones (mean difference = −1.15, $p<0.001$, 95%CI: −1.81 to −0.49) (Figure 2). When the covariates were controlled for, the results became nonsignificant [$F(2,3547) = 0.53$, $p=0.59$, adjusted $R^2= 0.47$]. The previous symptoms of depression measured in 1997 and 2001 attenuated the associations ($p>0.05$).

Thereafter, the longitudinal associations between adulthood physical activity (assessed in 2007, subjects' aged from 30 to 45) and symptoms of depression (measured in 2012) were studied. In the original sample, adulthood physical activity was related to depressive symptoms (b= −1.10, $p<0.001$, 95%CI: −1.58 to −0.61, adjusted $R^2= 0.01$). When the covariates were controlled for, the association attenuated to nonsignificance (b= −0.17, $p=0.62$, 95%CI: −0.85 to 0.51, adjusted $R^2= 0.24$). The symptoms of depression assessed in 2001 and 2007 attenuated the association ($p>0.05$). Thereafter, the analyses were conducted in a sample with full information on all study variables, in which case the adulthood physical activity was not related to depressive symptoms (b= −0.55, $p=0.16$, 95%CI: −1.31 to 0.21, adjusted $R^2= 0.00$). Due to the sample attrition, the association was examined also in the imputed data (N=3596), and the results indicated that the adulthood physical activity was associated with decreased levels of depressive symptoms (N= −1.07, $p<0.001$, 95%CI: −1.36 to −0.78, adjusted $R^2= 0.01$). When the covariates were taken into account, the association attenuated to nonsignificance (b=0.06, $p=0.57$, 95%CI: −0.16 to 0.28, adjusted $R^2= 0.47$). The symptoms of depression assessed in 2001 and 2007 attenuated the association ($p>0.05$).

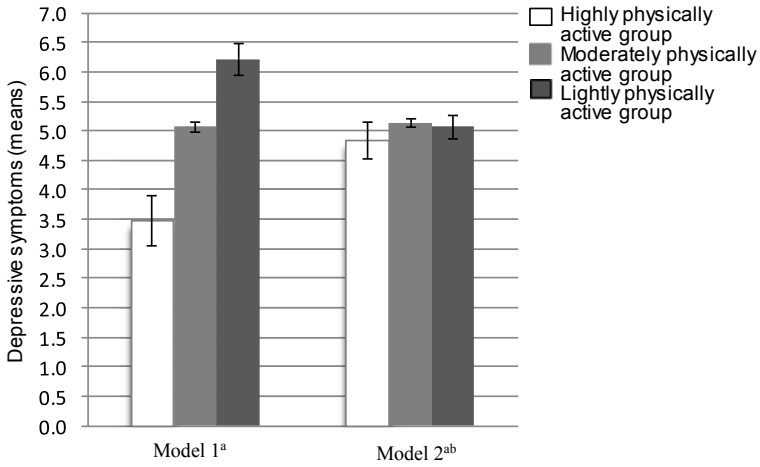

Figure 2. Depressive symptoms (2012) in the physical activity trajectory groups in unadjusted and adjusted models (N = 3564)

[a]Standard errors are shown in the figure by the error bars attached to each column.
[b]Subjects' age, sex, childhood negative emotionality, parental education, parents' income (1980), previous depressive symptoms (1992-2007), participants' education, income, social support, body mass index and smoking status (2007) were adjusted for in the analyses.

4.4 Lifestyle counseling and psychological well-being (Study IV)

Tables 12 and 13 provide the descriptives for the sample. The intervention receivers did not differ from the control group when the results for life satisfaction, self-reported health, stress experiences, the consequences of stress experiences or depressive symptoms were controlled for sex (Table 14, Model 1). Further adjustment for socioeconomic status did not have effects on the associations between groups and indicators of psychological wellbeing (Table 14, Model 2). Furthermore, no interactions between STRIP study group and parental education was found, indicating that childhood socioeconomic status did not moderate the effects of intervention on psychological well-being ($p>0.05$). Similar results were found when the educational levels of participants' mothers and fathers, respectively, were used in the analyses ($p>0.05$). The associations between the STRIP study group and indicators of psychological wellbeing remained primarily unchanged when the analyses were controlled for other socioeconomic factors. These variables were parental education and income determined in 2006, and participants' current educational status ($p>0.05$).

Table 12. Descriptive statistics of the psychological wellbeing indicators (N = 433–456).

Variables	Intervention group (N = 210)		Control group (N = 247)	
	No risk for the outcome variable, N (%)	Risk for the outcome variable, N (%)	No risk for the outcome variable, N (%)	Risk for the outcome variable, N (%)
Dissatisfaction with life	153 (72.9)	57 (27.1)	175 (71.1)	71 (28.9)
Experiences of not being healthy compared to others at the same age	90 (43.1)	119 (56.9)	99 (40.1)	148 (59.9)
Experiences of stress	92 (44.2)	116 (55.8)	108 (43.7)	139 (56.3)
Absences from school/work	149 (71.3)	60 (28.7)	190 (77.9)	54 (22.1)
Use of psychological healthcare services	155 (74.2)	54 (25.8)	193 (78.8)	52 (21.2)
Symptoms of depression	167 (84.3)	31 (15.7)	193 (82.1)	42 (17.9)

Table 13. Descriptive statistics[a] for socioeconomic factors (N = 276–457).

Variables	Intervention group (N = 210)	Control group (N = 247)
	N (%)	N (%)
Parental educational level (measured at the child's age of 13 months)		
Low	46 (31.7)	53 (31.7)
Average	54 (37.2)	61 (36.5)
High	45 (31.0)	53 (31.7)
Mother's educational level (measured at the child's age of 13 months)		
Low	50 (35.7)	64 (40.0)
Average	54 (38.6)	54 (33.8)
High	36 (25.7)	42 (26.3)
Father's educational level (measured at the child's age of 13 months old)		
Low	65 (50.1)	74 (50.3)
Average	41 (31.8)	38 (25.9)
High	23 (17.8)	35 (23.8)
Parental educational level (2006)		
Low	13 (10.1)	30 (17.3)
Average	65 (50.4)	75 (43.4)
High	51 (39.5)	68 (39.3)
Parental income (2006) (€/month)		
Less than €2,000	5 (3.9)	9 (5.4)
€2,001–€4,000	33 (26.0)	47 (28.1)
€4,001–€6,000	56 (44.1)	65 (38.9)
€6,001–€8,000	21 (16.5)	25 (15.0)
More than €8,000	12 (9.4)	21 (12.6)
Participant's educational level (measured at age 20)		
Low	87 (42.2)	123 (51.7)
Average	47 (22.8)	46 (19.3)
High	72 (35.0)	69 (29.0)

[a]Within the intervention group, 135 (64.3%) were female and 75 (35.7%) were male. Within the control group, 146 (59.1%) were female and 101 (40.9%) were male.

Table 14. STRIP group membership as a predictor for psychological well-being indicators (N = 312–456).

Outcome variables[a]	Predictors	Model 1[b]		Model 2[c]	
		OR (95% CI)	p	OR (95% CI)	p
Dissatisfaction with life	Intervention group	0.94 (0.62–1.42)	0.76	0.88 (0.53–1.46)	0.62
	Control group	Ref.		Ref.	
Experiences of not being healthy compared to others at the same age	Intervention group	0.85 (0.58–1.25)	0.41	0.81 (0.51–1.29)	0.37
	Control group	Ref.		Ref.	
Experiences of stress	Intervention group	0.94 (0.64–1.37)	0.74	0.88 (0.55–1.41)	0.60
	Control group	Ref.		Ref.	
Absences from school/work	Intervention group	1.39 (0.90–2.13)	0.14	1.60 (0.94–2.70)	0.08
	Control group	Ref.		Ref.	
Use of psychological health-care services	Intervention group	1.28 (0.82–1.97)	0.28	0.94 (0.55–1.63)	0.83
	Control group	Ref.		Ref.	
Symptoms of depression	Intervention group	0.84 (0.51–1.40)	0.51	0.81 (0.44–1.51)	0.51
	Control group	Ref.		Ref.	

OR, odds ratio.
[a]For dependent variables, a higher value (1) denotes a higher risk for adverse psychological outcomes.
[b]Analyses controlled for sex.
[c]Analyses controlled for sex and parents' educational status assessed during participants' childhood at the age of 13 months.

Supplementary Table 1. Study variables, measurement years and results.

Study	Variables	Measurement years	Results
Study I. Does Childhood Temperamental Activity Predict Physical Activity and Sedentary Behavior over a 30-Year Period? Evidence from the Young Finns Study	*Independent variable*		High temperamental activity assessed from ages 9 to 12 was associated with high levels of childhood physical activity in both genders, but with a steeper decline in physical activity levels during the first 9 years of follow-up in boys. High temperamental activity assessed from ages 3 to 6 was associated with the decline of physical activity from childhood to youth in girls. High childhood temperamental activity was associated with decreased levels of physical activity in adulthood in men, but not in women. The associations between childhood temperamental activity and TV viewing in adulthood seemed to be positive but not consistently significant in all age and gender groups.
	Temperamental activity	1980	
	Dependent variable		
	Physical activity	1980, 1983, 1986, 1989, 2001, 2007, 2011	
	TV-viewing	2001, 2007, 2011	
	Covariates		
	Parents' physical activity	1980	
	Parents' socioeconomic status	1980	
	School performance (GPA)	1980	
Study II. Parental physical activity associates with offspring's physical activity until middle age – a 30-year study	*Independent variable*		High levels of mothers' and fathers' physical activity were systematically associated with higher levels of their children's physical activity until offspring's age of 24. Longitudinal analyses conducted from 1980 to 2011 indicated that higher levels of parents' physical activity were associated with increased levels of physical activity within their offspring until middle age, but the association between parents' and their children's physical activity weakened when participants aged ($p<0.05$). Covariate adjustment did not attenuate the finding.
	Parents' physical activity	1980	
	Age	1980	
	Dependent variable		
	Physical activity	1980, 1983, 1986, 1989, 1992, 2001, 2007, 2011	
	Covariates		
	Birth cohort	1980	
	Living area	1980	
	Parents' cohabiting	1980, 1983, 1986, 1989	
	Parents' education	1980	
	Parents' income	1980	
	Subject's body mass index	2007	
	Subject's education	2007	
	Subject's income	2007	
	Subject's diet	2007	
	Subject's alcohol use	2007	
	Subject's smoking status	2007	
	Subject's social support	2007	

Study III. Trajectories of physical activity predict the onset of depressive symptoms but not their progression – a prospective cohort study	*Independent variable*		Highly, moderately, and lightly physically active trajectory groups were found. Highly active participants had lower levels of depressive symptoms compared to lightly active ones ($p<0.001$) and compared to moderately active ones ($p=0.001$). Moderately active participants had less symptoms than lightly active ones ($p<0.001$). High levels of adulthood physical activity associated with lower levels of depressive symptoms ($p<0.001$). The results did not withstand adjustment for previous depressive symptoms ($p>0.05$). Lifelong physical activity trajectories or adulthood physical activity were not associated with the progression of depressive symptoms in adult age. Physical activity history does not contribute to the progression of the depressive symptoms to a greater degree than adulthood physical activity.
	Physical activity	1980, 1983, 1986, 1989, 1992, 2001, 2007, 2011	
	Dependent variable		
	Symptoms of depression	2012	
	Covariates		
	Age	1980	
	Negative emotionality	1980	
	Parental education	1980	
	Parental income	1980	
	Symptoms of depression	1992	
	Symptoms of depression	1997	
	Symptoms of depression	2001	
	Symptoms of depression	2007	
	Subject's education	2007	
	Subject's income	2007	
	Social support	2007	
	Body mass index	2007	
	Smoking status	2007	
Study IV. Psychological wellbeing in 20-year-old adults receiving repeated lifestyle counselling since infancy	*Independent variables*		No association between the long-term dietary and lifestyle intervention and participants' psychological well-being in adulthood was found. Adjusting for sex and childhood socioeconomic status did not affect the results and socioeconomic status did not moderate the association between the intervention and psychological well-being.
	Strip group	1992	
	Dependent variables		
	Dissatisfaction with life	2012	
	Experiences of not being healthy compared to others at the same age	2012	
	Experiences of stress	2012	
	Absences from school/work	2012	
	Use of psychological healthcare services	2012	
	Symptoms of depression	2012	
	Covariates		
	Sex	1992	
	Mother's educational level	1992	
	Father's educational level	1992	
	Mother's educational level	2006	
	Father's educational level	2006	
	Participants' educational level	2012	

Supplementary Table 2. Longitudinal studies of physical activity.

Authors	Publishing year	Article title	Follow-up period
Telama, R., Leskinen, E., & Yang, X.	1996	Stability of habitual physical activity and sport participation: a longitudinal tracking study	1980-1992
Yang, X., Telama, R., & Laakso, L.	1996	Parents' physical activity, socioeconomic status and education as predictors of physical activity and sport among children and youths – a 12 year follow-up study	1980-1992
Yang, X., Telama, R., & Leskinen, E.	2000	Testing a multidisciplinary model of socialization into physical activity: a 6-year follow-up study	1986-1992
Telama, R., & Yang, X.	2000	Decline of physical activity from youth to young adulthood in Finland	1980-1989
Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O.	2005	Physical activity from childhood to adulthood: a 21-year tracking study	1980-2001
Telama, R., Yang, X., Hirvensalo, M., & Raitakari, O.	2006	Participation in organized youth sport as a predictor of adult physical activity : a 21-year longitudinal study	1980-2001
Schnohr, P., Lange, P., Scharling, H., & Jensen, J.	2006	Long-term physical activity in leisure time and mortality from coronary heart disease, stroke, respiratory diseases, and cancer	1976-1983
Yang, X., Telama, R., Hirvensalo, M., Hintsa, T., Pulkki-Råback, L., Hintsanen, M., … & Raitakari, O.	2012	Leadership component of type A behaviour predicts physical activity in early midlife	1986-2007
Azevedo Da Silva, M., Singh-Manoux, A., Brunner, E., Kaffashian, S., Shipley, M., Kivimäki, M., & Nabi, H.	2012	Bidirectional association between physical activity and symptoms of anxiety and depression	1985-1993
Pereira, S., Geoffroy, M., & Power, C.	2013	Investigation of bidirectional associations between depressive symptoms and physical activity from age 11 to 50 years in the 1958 British birth cohort	1969-2008 (approx.)
Telama, R., Yang, X., Leskinen, E., Kankaanpää, A., Hirvensalo, M. Tammelin, T., … & Raitakari, O.	2014	Tracking of physical activity from early childhood through youth into adulthood	1980-2007
Yang, X., Hirvensalo, M., Hintsanen, M., Hintsa, T., Pulkki-Råback, L., Jokela, M., …& Raitakari, O.	2014	Longitudinal associations between changes in physical activity and depressive symptoms in adulthood: the Young Finns study	2001-2007

5 DISCUSSION

Life course epidemiology focuses on long-term effects of biological, psychosocial and behavioral factors on well-being through distinct developmental stages (Kuh et al., 2003). It has been suggested that early experiences and adaptive responses may affect the development of well-being, without having a deterministic effect (Halfon & Hochstein, 2002). Importance of studying the risk and protective factors for health behaviors and well-being has been highlighted (Kuh et al., 2003; Hirvensalo & Lintunen, 2010; Sarafino & Smith, 2014). The aim of this dissertation was to shed light on whether and how early life factors, such as temperamental characteristics and parental behaviors, contribute to health behaviors, and whether lifestyles relate to psychological well-being in adulthood. Furthermore, the psychological effects of an intensive, 20-year life-style intervention were assessed.

The results indicated that childhood temperamental activity was not favorably associated with adulthood physical activity. Some positive associations between temperamental activity and sedentary behaviors (TV viewing) were found. Parents' physical activity assessed in children's childhood and adolescence contributed to the development of their offspring's physical activity until middle age. Participants, who had been physically active from childhood to adulthood, had lower levels of depressive symptoms than participants with less active physical activity histories. If participants had suffered from previous symptoms of depression during their adult age, being physically active from childhood to adulthood did not associate with decreased levels of depressive symptoms later in life. The results also showed that lifelong physical activity did not contribute to depressive symptoms to a greater degree than adulthood physical activity. Finally, the infancy-onset, 20-year lifestyle intervention did not associate with the examined indicators of psychological well-being in adulthood. The summaries of the findings can be found from Supplementary Table 1. Previous longitudinal studies of physical activity, which are also considered in the text, are presented in Supplementary Table 2.

5.1 Childhood antecedents of lifelong physical activity

5.1.1 Participants' temperamental activity

Childhood temperamental activity assessed at ages 9 to 12 was associated with decreased levels of physical activity in adulthood within males. Temperamental activity assessed at children's ages 3 and 6 associated also with higher levels of TV viewing in males, and temperamental activity assessed at ages 9 and 12 within females. The associations varied to some degree depending on the covariates adjusted for in the models.

The results are in the same direction with previous literature regarding temperament, behavioral and health outcomes. The association between temperamental activity and TV viewing in adulthood is in agreement with some of the studies regarding temperamental activity and sedentary behavior (Øglund et al., 2014). High temperamental activity in childhood has also been shown to associate with later poor school performance (Alatupa et al., 2011). Furthermore, it has been denoted that temperamental activity may relate to risk of later diagnosis of attention deficit hyperactivity disorder (ADHD) (Nigg et al., 2004). Temperamental activity and adulthood atherosclerosis have also shown to be associated (Keltikangas-Järvinen et al., 2006).

The mechanisms between temperamental activity, decreased levels of physical activity and sedentary behaviors may be associated with biological processes (Donzella et al., 2000). Literature has postulated that high temperamental activity may relate to lack of behavioral control and regulation (Nigg et al., 2004). Therefore, high levels of temperamental activity may be a vulnerability factor for the formation of total energy output (Buss & Plomin, 1984). Thus, we can cautiously suggest that high temperamental activity may contribute to irregular behavioral styles, which may, in turn, reduce the potential of developing physical activity habits which require more or less systematic behavioral functioning (e.g., Telama et al., 2006). Previous study has shown that lack of self-regulation associates with unhealthy dietary behaviors and alcohol consumption in adulthood (van den Bree et al., 2006), suggesting that self-regulation might play an essential role in temperament's and lifestyle's association.

Life course perspectives have accentuated the need for studying the early life factors, including the biopsychological ones, in relation to lifestyles and well-being (Kuh et al., 2003; Hirvensalo & Lintunen, 2010; Øglund et al., 2014). This study showed that certain individual dispositions such as childhood temperamental activity may not contribute to high levels of physical activity from childhood to adult age. It is possible that high levels of temperamental activity in

childhood are a risk factor for the development of healthy lifestyle. Further studies assessing whether a child's ability to self-regulate behaviors mediates the association between temperamental activity and physical activity during the life course are needed.

5.1.2 Parents' physical activity

Mothers' and fathers' physical activity was systematically associated with the increased levels of children's physical activity until offspring's age of 24. The main findings indicated that higher levels of parents' physical activity were related to higher activity levels in offspring until middle adulthood, although the effects weakened as the participants aged. Covariate adjustment did not attenuate the associations.

The cross-sectional and longitudinal examinations indicated that high levels of both parents' physical activity were associated with increased levels of children's physical activity in childhood and adolescence, which is in accord with previous literature (Dollman, 2010). Previous studies in the same data have have shown that fathers' physical activity contributes to offspring's late childhood and adolescent physical activity (Yang et al., 1996; Yang et al., 2000). This study extends the knowledge by demonstrating mothers' physical activity's significance on that of their offspring's. Furthermore, the longitudinal analyses from childhood to adulthood (1980-2011) accentuated the importance of both parents' physical activity for children's physical activity until middle age.

Literature has denoted that health beliefs and behaviors learned from a family during childhood tend to remain relatively stable throughout life (Lau et al., 1990). Behavioral modeling could partly explain the associations between parents' and their children's physical activity in distinct phases of life. Previous examinations have also demonstrated the importance of parental social support in the formation adolescents' physical activity (Cheng et al., 2014). Some evidence indicates that fathers invest more time on playing with their children than mothers (Lamb et al., 2004), but mothers may also be active playmates or sporting activity organizers for their offspring. Parents might have thus stimulated their children's interest to physical activities, and possibly also facilitated children's access and engagement to these activities. The relations between parents' and their children's physical activity may also be culturally mediated (Bauman et al., 2012; Lamb, 2004). Along with the interpersonal and environmental correlates, genetic contributors may predispose a person to physical activity or inactivity (Bauman et al., 2012).

Along with accentuating the need for studying biopsychological factors, life course perspectives have paid attention to the need for assessing the social and environmental factors in relation to life-styles and well-being (Kuh et al., 2003; Hirvensalo & Lintunen, 2010). This study showed that both parents' physical activity habits assessed in their children's chilhood and adolescence contributed favorably to the development of their offspring's physical activity from childhood to middle age. The findings were not affected by later life factors, including socioeconomic and psychosocial ones. Thus, parents' physical activity may promote the development of their offspring's physically active lifestyle. Further studies could examine the mechanisms. Parental modeling, parents' and children's common activities, as well as social and instrumental support gained from parents may mediate the association between parents' and their offspring's physical activity during the life course.

5.2 Lifelong physical activity in relation to psychological well-being

The study found three developmental trajectories of physical activity from childhood to adulthood, the lightly, moderately, and highly physically active ones. Physical activity levels remained approximately similar from childhood to adulthood in each trajectory, although the trajectories' physical activity levels decreased slightly towards middle adulthood. High physical activity associated with lower level of depressive symptoms in adulthood, but the association attenuated after controlling for the subjects' pre-existing symptoms of depression. These same results were found when lifelong physical activity trajectories and adulthood physical activity (assessed in 2007) were used as predictors for depressive symptoms in adulthood.

This study demonstrated that physical activity trajectories remained approximately similar from childhood to adult age, which gives support to the literature indicating that lifestyle's tend to be relatively stable from childhood to adulthood (Telama et al., 2014). This study showed also that high levels of physical activity associated with lower levels of depressive symptoms in adult age, which is also in accord with previous research (Teychenne et al., 2008; Yang et al., 2014).

The mechanisms behind the observed association can be both physiological and psychosocial. Physical activity may associate with decreased levels of depressive symptoms through neurobiological alterations (Helmich, 2010). Physical activity may also relate to increased self-confidence and emotion regulation skills contributing to positive mood (Crust, 2008).

Furthermore, social relations within the exercise contexts are likely to associate with well-being (Crust, 2008; McAuley et al., 2000).

The association between high physical activity and lower levels of depressive symptoms in adulthood, however, attenuated when subjects' previous symptoms of depression were controlled for. These results also extend the previous studies on physical activity and adulthood symptoms of depression, in which the history of depressive symptoms was not thoroughly controlled for (Yang et al., 2014). The bidirectional nature of the association between physical activity and depression has been documented in previous examinations (Pereira et al., 2013; Azevedo da Silva et al., 2013). Hence, it is theoretically possible that the childhood symptoms of depression preceding our first measurement have diminished the likelihood of initiating physical activity (Pereira et al., 2013; Azevedo da Silva et al., 2013) or that of maintaining sufficient level of physical activity (Azevedo da Silva et al., 2013).

Life course perspective has highlighted the importance of studying lifestyles' association to the development of disease risk (Kuh et al., 2003). Furthermore, it has been pointed out that more information of the potentially critical times in engaging or quitting sports participation during the life course is needed (Hirvensalo & Lintunen, 2010). This study indicated that lifelong physical activity trajectories and adulthood physical activity levels were associated with decreased levels of depressive symptoms approximately to the same degree. Thus, being physically active in adulthood may benefit psychological well-being regardless of a person's previous physical activity history. However, when the previous symptoms of depression were adjusted for in the models, neither lifelong or adulthood physical activity contributed to the progression of depressive symptoms. Future studies could focus on studying more thoroughly the potentially mediating roles of neurobiological factors, self-confidence, -regulation, and social relatedness with respect to physical activity and psychological well-being.

5.3 Lifestyle counseling in relation to psychological well-being

No association between the infancy-onset, 20-year lifestyle intervention and the psychological well-being indicators was found. These indicators included participants' satisfaction with life, experiences of health compared to others at the same age, experiences of stress, absences from school/ work, use of psychological healthcare services, and symptoms of depression assessed in participants' adulthood. Covariate adjustment did not affect the associations.

While the 20-year STRIP intervention did not straightforwardly target improving participants' psychological well-being, psychological and physical health have been shown to be closely, if not inextricably, related to each another (Prince et al., 2007; Sarafino & Smith, 2014). The psychological themes discussed during the counseling sessions might have contributed to the development of the participants' self-esteem, health behaviors and psychological well-being. Changes in health behaviors resulting in improved levels of physical well-being in the STRIP study (Simell et al., 2009) might have been related also with psychological well-being (Prince et al., 2007; Sarafino & Smith, 2014). Furthermore, although the intervention was hypothesized to potentially favor psychological well-being, the possibility that some subjects experienced unpleasant feelings while taking part in an intensive lifestyle counseling trial from infancy to adulthood should not be ignored. However, no evidence to support the psychological effects of the intervention was found in this study, suggesting that the intervention seemed to be psychologically safe given the examined indicators of well-being.

The results are in agreement with previous studies conducted within the same cohort, indicating that the intervention did not notably affect psychological development in childhood (Tarmi-Mattson et al., 1997). Previous dietary interventions (Talvia et al, 2013) have not assessed thoroughly the potential psychological side-effects. Furthermore, our results are not perfectly in accord with previous evidence derived from shorter lifestyle interventions in which the participants' experienced well-being had improved (Melnyk et al., 2009; Blank et al., 2007).

The importance of assessing intensive longitudinal lifestyle interventions' side-effects has been acknowledged (Tarmi-Mattson et al., 1997). The 20-year STRIP intervention did not appear to carry psychologically negative effects. Longitudinal, intensive intervention including also physical activity counseling seemed to be psychologically safe with respect the examined psychological well-being indicators. Thus, it is likely that systematic lifestyle interventions containing physical activity counseling can be given to people from infancy to adulthood with no risk of unintended psychological effects.

5.4 Limitations and strengths

5.4.1 Contents of the variables

The questionnaires concerning physical activity (studies I-III) and TV viewing (study I) captured only limited number of domains related to the constructs of physical activity and sedentary

behaviors. For instance, work related physical activity and occupational sitting time were not assessed in this thesis' studies. In addition, the measurements concerning the participants' physical activity were self-reported, as well as the ones regarding TV viewing.

Furthermore, the variables assessing parental physical activity were concise (Study II). Maternal evaluations of children's temperamental activity were also succinct, as the questionnaire entailed only the level of motor activity (Study I). The psychological well-being indicators were short one-item questions (Study IV). Participants' depressive symptoms were studied with a self-report questionnaire instead of categorical diagnoses (Study III). The possibility of subjective bias' influence on the results cannot be perfectly excluded. It is also possible that participants may have been able to evaluate some of the questions more accurately than others (e.g., the frequency of organized sports activities vs. unorganized ones) (Telama et al., 1996). Furthermore, the conciseness of some of the variables might have limited the possibility to capture the phenomena.

Subjective evaluations have, however, shown to correlate with (more) objective assessments (Mansikkaniemi et al., 2012; Tudor-Locke et al., 2004; Wang et al., 2013). BDI-II has also shown to be a useful screening tool for future mental disorders (Wang et al., 2013). The examined indicators of experienced well-being can be seen as reflecting the relevant aspects of psychological well-being, including the cognitive and emotional ones, and mastery (Ryff, 1989; Ryan & Deci, 2001; Diener et al., 2002). Short instruments have also long been used in population surveys to assess health-related factors due their brevity (Bowling, 2005). Literature has also demonstrated satisfactory levels of reliability and validity of single-item instruments (Bowling, 2005).

5.4.2 Measurements

Physical activity questionnaires used in the Studies I-III differed slightly regarding their content among younger children, adolescents and adults. It is important to take under consideration the age-related developmental phases within participants, and therefore some of the questionnaire items were changed and/ or formulated differently for distinct age groups. However, such changes within the original questions may cause challenges when attempting to model the development of a specific (latent) construct in a lifelong design. The differences within the original scales can therefore be regarded as a limitation, although the age-related modifications within the questions were inevitable. Furthermore, the measurements were conducted unequal intervals (1980, 1983,

1986, 1989, 1992, 2001, 2007, and 2011).

Research on the intra-individual change in physical activity within time has, however, given evidence that the stability of physical activity is sufficient for longitudinal analysing purposes (Telama ym., 1996). Furthermore, this thesis found support for the measurement invariance for the physical activity indices derived from the physical activity questionnaires used among 9- to 49-year-olds (Studies II and III). Although a minor deviation from full invariance was found due to one question, the fit indices indicated acceptable model (Cheung & Rensvold, 2002). Previous examinations have also allowed for partial measurement invariance within longitudinal models (Muthén, 2002), and there exists research demonstrating that partial invariance is not likely to be problematic when the models are correctly specified (Kim & Willson, 2014). In this thesis, the estimated factor scores from the measurement invariance model correlated highly with the original physical activity indices from participants' childhood to adulthood (1980-2011) (coefficients >0.90). These findings provided the possibility to study the latent construct, physical activity, over several age-related transitions from childhood to middle age. In addition, the used growth modeling techniques allow for modeling repeated measurements with unequal intervals (Hox & Roberts, 2011; Lott & James, 2013).

5.4.3 Attrition

Participants did not provide information regarding each variable across the measurement years, which diminished the sample sizes in each of the four studies. This can be seen as a limitation. Data attrition is, however, unavoidable in studies continuing for decades. The modern statistical methodologies used in the present work deal efficiently with missing cases (Curran et al., 2010). We also controlled for the potential attrition bias via an imputation method in the Study III, in which the lack of participants was exceptionally high. It has also been suggested that the data affected by selective attrition could be compared to datasets with no attrition (e.g., registry-based ones) to evaluate the potential bias within the observed associations (Jokela, 2012).

Despite the attrition, one of the most evident strength of the Studies I-III was the prospective, population-based cohort study design that had continued over 30 years. Furthermore, we had the possibility to use the data from an infancy-onset lifestyle intervention trial, in which the participants had received lifestyle counseling for 20 years. In addition, both datasets contained extensive sets of covariates which provided the possibility to further test the findings in each study. If severe multicollinearity was detected, a covariate was excluded from the model (e.g., Study II,

Table 8). Finally, all the studies were conducted within a predominantly homogeneous Finnish datasets. Thus, the results can be only cautiously generalized to other populations, specifically to those with high levels of socioeconomic and ethnic differences.

5.4.4 Methodological considerations

A multiple set of methodologies were used in cross-sectional (Study IV) and longitudinal studies (Studies I-III), which can be regarded as a strength of this dissertation. Within Studies I-III, distinct growth curve modeling techniques were applied, including linear growth curve modeling within a multilevel context (Study I), linear mixed modeling (Study II), and latent class growth modeling (Study III). Such methods are becoming common techniques in understanding development, causes, and consequences of health behaviors over time (Curran et al., 2010) within behavioral and medical sciences. Furthermore, these methods are particularly relevant for testing life course models (Kuh et al., 2003).

The modern growth modeling techniques have several benefits over traditional analyzing methods (i.e., repeated measures ANOVA). Most especially, they are flexible in dealing with variety of complexities typically occurring in longitudinal datasets (Curran et al., 2010). For instance, partially missing data can be included to the models, and variables with non-normal distributions as well as repeated measurements with unequal intervals can be used (Hox & Roberts, 2011; Lott & James, 2013). Furthermore, growth modeling techniques allow for examining differently shaped trajectories, time-varying covariates and multivariate growth processes (Hox & Roberts, 2011; Lott & James, 2013). Use of growth curve modeling framework was essential within Studies I-III, in which the datasets contained missing values, participants were nested regarding repeated measurements, extensive set of covariates were controlled for, and the development / time-contingent change within health behaviors was in focus. The distinct growth curve models were, moreover, utilized in conjuction with more conventional statistical methods (i.e., correlational and linear regression analyses) within each examination (Studies I-III).

5.5 Conclusions and practical implications

This thesis examined the potential effects of early life factors, including temperamental activity and parents' physical activity, on the development of physical activity from childhood to adulthood. The thesis examined also whether and how lifelong physical activity was associated with psychological

well-being in adulthood. In addition, the potential psychological effects of a 20-year, intensive lifestyle intervention were studied.

The results from the first study indicated that high temperamental activity in childhood did not associate with physically active lifestyle from childhood to adulthood. In the Study II, high levels of parents' physical activity were associated with increased levels of physical activity in offspring from childhood to middle age. Study III identified three distinct physical activity trajectory groups, the lightly, moderately, and highly physically active ones. Highly physically active participants had lower levels of depressive symptoms in adulthood compared to lightly physically active ones. However, physical activity was not associated with depressive symptoms when the previous symptoms of depression were controlled for. The Study IV showed no association between lifestyle counseling delivered by health professionals over a 20-year period and psychological well-being in adulthood.

Each study contributes to both scientific theory and practice. Studies I and II extend knowledge of early life factors' contribution to lifelong physical activity. It has been speculated whether and which environmental and individual characteristics associate with the development and maintenance of lifestyles and well-being (Kuh et al., 2003; Bauman et al., 2012). To date, literature has been lacking evidence of how far-reaching the potential effects of specific early childhood factors are within the life course. Study I showed that childhood temperamental activity did not contribute to physically active lifestyle from childhood to adult age. Literature has denoted that high temperamental activity may relate to lack of behavioral control and regulation (Nigg et al., 2004). Therefore, high levels of temperamental activity may reduce the potential of developing physical activity habits requiring systematic training. This study extends the previous literature (Øglund et al., 2014) by showing that specific individual dispositions such as childhood temperamental activity may not contribute to physical activity over the life course.

As the children's temperamental characteristics are relatively unchanged (e.g., Buss, 1991), it is especially important that parents, caregivers, teachers and leisure-time activity leaders pay attention to the contents of sports activities, as well as to the interpersonal and environmental contexts in which the activities are performed. For instance, evaluating different sports within distinct educational and leisure-time settings in relation to child's or child group's temperamental activity might be useful in designing physical activities. Furthermore, children's age-related developmental stages should be taken into account when utilizing the information of temperamental activity differences. Obtaining information from children regarding their motivations and likes might also be beneficial in inventing and implementing activities.

The Study II indicated that high levels of parents' physical activity were associated with increased levels of physical activity in offspring from childhood to middle age. As parents' physical activity habits contributed their children' activity far into adulthood, it is essential to pay attention to parental models, parents' and children's common activities, as well as on social and instrumental support through which the parents' effects on their offspring may at least partly come. Overall, it seems that social environment plays an important role regarding the lifestyles development, and it is possible that it may impede or support the child's predisposition for physical activity (Bauman et al., 2012). This study extends the previous literature (Yang et al., 1996; Yang et al., 2000; Dollman, 2010) by demonstrating both' parents' physical activity's importance on that of their offspring's until middle age. This information might be useful for parents, caregivers, and family-based intervention designers who aim to support physical active lifestyles' development during the life course.

Study III extends the knowledge of physical activity's association with psychological well-being. Both lifelong physical activity and adulthood physical activity were associated with decreased levels of depressive symptoms approximately to the same degree. Being physically active in adulthood may benefit psychological well-being regardless of a person's previous physical activity history. Thus, this study also offers some perspectives of the role of physical activity in various life stages (Hirvensalo & Lintunen, 2010). However, taking into account the pre-existing symptoms of depression, lifelong physical activities or changes in these activities did not prevent risk of future depressive symptoms. The same results were found when adulthood physical activity was used as a predictor for depressive symptoms. These information might benefit health professionals evaluating the role of physical activity for psychological well-being during the life course.

The Study IV found no association between the infancy-onset, 20-year lifestyle intervention and the examined psychological well-being indicators. The results from the study IV extend the knowledge of the potential psychological side-effects regarding dietary and lifestyle interventions. The results suggest that intensive lifestyle intervention containing physical activity counseling can be systematically given to a general population from infancy to adulthood with no apparent risks for psychological well-being. The information might be useful to be considered when designing and applying, for instance, evidence-based clinical practice guidelines, which are usually intended for a basis of decisions regarding disease prevention. When designing lifestyle interventions which also aim at improving psychological well-being, it might useful to consider techniques supporting the core elements of psychological well-being including self-acceptance,

inner growth, purpose in life, positive relatedness, mastery, and autonomy (Ryff, 1989; Ryff & Singer, 2008) in distinct life stages.

Along with providing extensions to scientific and practical knowledge, this thesis pointed out the need for further studies. Further examinations could study the potential mediators, such as self-regulation, in the association between temperamental activity and physical activity. An interaction between childhood temperamental activity and support for physical activity gained from parents, and possibly from other important social agents, could be studied with regard to lifelong physical activity. Furthermore, examinations concerning the mechanisms through which the health behavior transmission occurs between parents and their children are needed. Parental modeling, parents' and children's common activities, as well as social and instrumental support gained from parents may be potential mediators. Additionally, it would be important to assess the role of neurobiological factors, as well as self-confidence, -regulation, and social relatedness in the link between lifelong physical activity and psychological well-being. Future studies could also address longitudinal lifestyle interventions' potential psychological safety within distinct populations. Through its contribution to science, this thesis provides information that might benefit professionals in tailoring, timing and targeting physical activity promotion actions and interventions aiming at improving community well-being.

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