Mental well-being in adolescence and young adulthood

Changes and association with fitness and physical activity

G. Sunna Gestsdóttir

Dissertation submitted in partial fulfillment of a Ph.D.-degree

UNIVERSITY OF ICELAND
SCHOOL OF EDUCATION

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This is for
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Abstract

Background: The transition from adolescence to young adulthood is marked by many changes. Mental well-being plays an important role in how individuals deal with these changes, and how they develop their lifestyle. In parallel with a worldwide decrease in physical activity, both physical and mental well-being have declined in young people.

Aim: The main aim of this study is to shed light on the changes occuring in mental well-being from age 15 to age 23 and to study how mental well-being is associated with fitness and physical activity.

Methods: The sample included N = 443 15-year-old students who participated at baseline and at follow-up when they were 23 years old (N = 201). Participants answered questions regarding their mental well-being (body image, self-esteem, anxiety, depression and somatic complaints) and fitness. Physical activity, fitness, and body composition were assessed objectively. Various statistical analyses were used to assess the data.

Results: General trends in changes from age 15 to 23 included increased self-esteem but decreased life satisfaction, anxiety, and somatic complaints. No changes were found in participants' body image or depression during the period. Fitness and physical activity decreased, body mass index increased, but no change was found in skinfold thickness. Regarding gender differences, females' self-esteem increased more than males' self-esteem, and physical activity, fitness, and body mass index worsened more in males than females. Males had better scores than females on body image, anxiety, depression, and somatic complaints, independent of age. Adolescent males had better self-esteem than adolescent females, but no gender difference was found in young adulthood. Females were more satisfied with life than males at follow-up. Cross-sectional analyses revealed no associations between physical activity and body image across age and gender, but aerobic fitness was related to adolescent males' body image. Self-reported fitness, depression and body composition were associated with females' body image at both ages and males' body image at age 23. In longitudinal analyses, the strongest association was found between aerobic fitness at age 15 with body image at age 23, independent of gender, physical activity, self-reported fitness, body mass index and body image at age 15. Mediation analysis of the cross-sectional relations of aerobic fitness and self-esteem through body image resulted in an indirect association between fitness and self-esteem, both at baseline and at

follow-up. Body image fully mediated the relation at baseline but did so partially at follow-up.
Conclusion: Gender differences in mental well-being in adolescence, favoring men, are not as lasting as previously thought. Objectively measured fitness in adolescence is an independent predictor of body image in young adulthood, whereas self-reported fitness is not. The effect of aerobic fitness on self-esteem was mediated by body image. It is likely that different methods are needed to improve body image and self-esteem males and females.

Ágrip (Abstract in Icelandic)

Inngangur: Unglingsárin skipa mikilvægt en oft á tíðum erfitt mótunartímabil. Andleg líðan á þessu aldurskeiði getur skipt sköpum fyrir framtíðar lífsstíl og velferð ungmenna. Á undanförnum árum hefur andlegri heilsu ungmenna hins vegar hrakað og hreyfing ungs fólks minnkað.

Markmið: Meginmarkmið rannsóknarinnar er að skoða breytingar á andlegri líðan ungmenna milli 15 og 23 ára aldurs og kanna hvernig andleg líðan tengist þreki og hreyfingu.

Aðferð: Þátttakendur, er tóku þátt í langtímarannsókn á heilsufari og líðan við 15 ára aldur (N = 443), var fylgt eftir átta árum síðar við 23 ára aldur (N = 201). Ungmenni komu af höfuðborgarsvæðinu og norðausturhluta Íslands. Þátttakendur svöruðu spurningum um þrek og andlega líðan (líkamsmynd, sjálfsálit, kvíða, þunglyndi og sálvefræn einkenni). Þrek var jafnframt metið með hlutlægum mælingum líkt og hreyfing, líkamsþyngdarstuðull og þykkt húðfellinga. Ólíkum tölfræði aðferðum var beitt við úrvinnslu gagna.

Niðurstöður: Breytingar á andlegri líðan frá unglingsaldri til snemmfullorðinsára voru þær að sjálfsálit þátttakenda jókst, það dró úr kvíða og sálvefrænum einkennum en lífsánægja minnkaði. Engin breyting var á líkamsmynd né þunglyndi. Breytingar á líkamlegu atgervi voru þær að þrek og hreyfing þátttakenda minnkaði yfir tímabilið, líkamsþyngdarstuðll jókst en engin breyting varð á þykkt húðfellinga. Skoðun á kynjamun á breytingunum yfir tíma sýndi að sjálfsálit kvenna jókst meira en karlar yfir tímabilið og á sama tíma versnaði þrek og hreyfing karla meira en kvenna. Jafnframt jókst líkamsþyngdarstuðull karla meira en kvenna. Karlar voru hins vegar með betri líkamsmynd, minni kvíða og þunglyndi og færri sálvefræn einkenni en konur óháð aldri. Karlar voru með meira sjálfsálit en konur við 15 ára aldur en enginn munur var á sjálfsáliti kynjanna átta árum síðar. Konur voru ánægðari með lífið en karlar 23 ára. Karlar voru með betra þrek, hreyfðu sig meira og voru með hærri líkamsþyngdarstuðul en konur óháð aldri. Þversniðssamband hreyfingar og þreks við líkamsmynd sýndi að engin tengsl voru milli hreyfingar og líkamsmyndar en þrek (hlutlæg mæling) hafði tengsl við líkamsmynd hjá 15 ára drengjum. Huglægt mat á þreki, þunglyndi, líkamsþyngdarstuðull og þykkt húðfellinga höfðu tengsl við líkamsmynd kvenna óháð aldri sem og hjá 23 ára körlum. Langtímasamband þreks (mælt huglægt og hlutlægt) við 15 ára aldur og líkamsmyndar við 23 ára aldur leiddi í ljós að hlutlægt mat á þreki við 15 ára aldur hafði sterkustu tengslin við líkamsmynd við 23 ár aldur, óháð kyni,

hreyfingu, líkamsþyngdarstuðli og líkamsmynd við 15 ára aldur. Jafnframt kom í ljós að líkamsmynd miðlar (e. mediates) sambandi þreks (hlutlægt) við sjálfsálit að fullu við 15 ára aldur en að hluta til við 23 ára.
Ályktun: Það dregur úr kynjamun á andlegri líðan frá unglingsárum fram á snemm-fullorðinsár. Þrek á unglingsaldri spáir fyrir um líkamsmynd á snemm-fullorðinsárum. Áhrif þreks á sjálfsálit er miðlað með líkamsmynd óháð aldri. Nálgast þarf kynin með ólíkum hætti þegar efla á líkamsmynd og sjálfsálit ungra einstaklinga.

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Reykjavík, January 30, 2016

Sunna Gestsdóttir

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Paper 2:

Gestsdottir, S., Svansdottir, E., Sigurdsson, H., Ommundsen, Y., Arnarsson, A., Sveinsson, T., Arngrimsson, S., and Johannsson, E.. **The association between physical activity, fitness and body image in adolescence and young adulthood – An eight-year follow-up study**. Submitted January 2016

Paper 3:

Gestsdottir, S., Svansdottir, E., Ommundsen, Y., Arnarsson, A., Arngrimsson, S., Sveinsson, T., and Johannsson, E. (2015). **Do aerobic fitness and self-reported fitness in adolescence differently predict body image in young adulthood? An eight-year follow-up study**. *Mental Health & Physical Activity*, doi:10.1016/ j.mhpa.2015.12.001.

1 Background

1.1 The transition from adolescence to young adulthood

For most of the 20th century, it was widely accepted that the period of adolescence was a time of "storm and stress". This view was introduced in 1904 by G. Stanley Hall, an American psychologist interested in the education and development of children (Goossens, 2006a). According to this idea, adolescence is described as a stormy process with risky behavior, rich in negative emotions as well as relationship problems with loved ones, especially parents (Goossens, 2006a). Initially, this was supported by Freud and the psychoanalytic perspective and influenced Erikson's (1968) theories of adolescence as a time of identity crisis (Goossens, 2006a). However, in the 1980s, this view started to change after new findings, based on empirical data on biological-environmental development, cognitive development, and social conditions (Goossens, 2006a).

Today, adolescence is defined as a journey or a special period of adjustment to adulthood, when persons go through rapid physical, social and cognitive changes (Santrock, 2011). Being able to take responsibility in managing and organizing your life path is now more widely accepted as "being an adult" (Goossens, 2006b). According to Sawyer et al. (2012), adolescence has never before been as long as it is in the 21st century. Over the last 40 years, the time from the onset of puberty to acquiring an independent, responsible role in society has increased. During the period from adolescence to young adulthood, individuals start establishing their lifestyle patterns, their personal identity forms, and certain habits and health-related behaviors form that tend to be stable throughout life (Baranowski et al., 1997; Kling, Hyde, Showers, & Buswell, 1999). Many adolescents also face transition from secondary school to university, which involves changes in their educational and social environment, as well as adaptations that may affect their physical and psychosocial well-being and choices of lifestyle behaviors (Baranowski et al., 1997). During this period, the foundation for future mental well-being is laid.

In 1992, Offer & Schonertreichl pointed out that, on the surface, adolescence appears to be one of the healthiest periods of the life course. Teenagers have survived the infectious ailments of childhood, and most of them have not yet developed chronic conditions or experienced declines in health associated with later adulthood. However, it no longer seems true that

adolescence is the healthiest time of life. In 2011, Viner et al. published numbers from the World Health Organization (WHO) mortality database (between 1955-2004). These figures indicate that mortality among adolescents is now greater than for 1- to 9–year-olds. This conclusion reverses the traditional dominant mortality patterns. Adolescents are nowadays more vulnerable than previously thought to the largely preventable morbidity and mortality related to injuries, diabetes, obesity and mental health (Viner et al., 2011). Even though the majority of adolescents go through this period of life successfully, reporting a level of relatively good well-being and few specific traumas, the media's attention continuously focuses on delinquency and ill-being during this period (Ambert, 1997; Heaven, 2001). Due to changes in the labor market in the recent past, as well as demographic and sociocultural changes, the years from age 15 to age 23 are more transitional, complex, and challenging than before and have essentially delayed adulthood (Zarrett & Eccles, 2006). This delay has been associated with adolescents' previously mentioned decline in mental well-being. Of note, as longer periods of education, increased affluence, and effective contraception have led to delay of adulthood, a relatively new term, *emerging adulthood*, has arisen. Jeffrey Jensen Arnett coined this term during his work on the evolving social roles of young adults, aged 18 to 25 (Arnett, 2000). Nevertheless, in this dissertation the concepts adolescence and young adulthood will be used when referring to participants' developmental stages.

1.2 Mental well-being

Many different definitions of mental well-being have been presented since WHO first introduced the concept in 1948 in its holistic definition of health: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (Bertolote, 2008). WHO defines mental health (frequently introduced as positive mental health) as "a state of well-being in which the individual realizes his or her abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community" (World Health Organization, 2001). In the academic literature, there has been some discussion of whether mental well-being and mental illness represent two ends of a single spectrum, or whether they are two separate dimensions. At least, a broad consensus exists that mental well-being is more than the absence of mental illness. In the recent past, the concepts of mental well-being and mental health have even become central to political debate. A variety of key European policy papers have acknowledged these concepts as fundamental to the quality of life and

productivity of individuals, families, communities and nations (European Communities, 2005; World Health Organization, 2005).

Mental well-being is associated with many aspects of health and social functioning, including mortality, and it has also grown in economic importance (Weich et al., 2011). Even though economists recurrently quantify mental well-being by using a one-item *happiness measure* (Blanchflower & Oswald, 2009), it is now largely accepted that mental well-being covers two perspectives: 1) the subjective experience of happiness (affect), life satisfaction and interest in life (*the hedonic perspective*); and 2) positive or optimal psychological functioning, good relationships with others and self-realization or personal growth (*the eudaimonic perspective*) (Manderscheid et al., 2010; Ryan & Deci, 2001; Westerhof & Keyes, 2010).

1.2.1 The hedonic view

The hedonic perspective of mental well-being reflects the view that well-being consists of pleasure or happiness and concerns judgments about the good vs. bad elements of life (Kahneman, 1999). The hedonic view dates all the way back to the fourth century B.C. when the Greek philosopher Aristippus said that happiness was the totality of one's hedonism. He taught that the goal of life was to experience the maximum amount of pleasure (Ryan & Deci, 2001). Within the hedonic perspective, the continuum between pleasure and pain in humans is assessed as a measure of subjective well-being (SWB) (Ryan & Deci, 2001). SWB comprises three elements: 1) life satisfaction; 2) the presence of positive mood; and 3) the absence of negative mood. These three components are often summarized together as happiness. Even though the degree to which SWB adequately defines psychological wellness has been debated (Ryff & Singer, 1998), SWB has ruled as the primary index of well-being for at least the past decade (Ryan & Deci, 2001).

1.2.2 The eudaimonic view

The eudaimonic perspective of mental well-being distinguishes it from happiness per se. The premise of this view is that some outcomes are not good for people (Ryan & Deci, 2001). Thus, not all desires or outcomes people value yield wellness once achieved. This view, just like the hedonic one, originates from ancient Greek philosophy. Aristotle considered hedonic happiness to be a vulgar ideal, making humans slavish followers of desires (Ryan & Deci, 2001). In 1993, Waterman presented the eudaimonic concept of well-being. It calls for individuals to live in congruence with their "daimon", or true self. Waterman's view was that eudaimonism is more associated with individuals being challenged by and involved in activities affording personal growth and

development, while hedonism is more related to being relaxed, apart from problems, and happy (Waterman, 1993). Ryan and Deci (2001) point out that another view that also embraces the concept of eudaimonia, or self-realization, as a central definitional aspect of well-being—Self-Determination Theory (SDT). It describes the conditions facilitating rather than undermining well-being and attempts to explain both how it is possible to actualize the self, and what this means. In relation to the eudaimonic view that well-being is about human flourishing, Ryff and Keyes (1995) created the term Psychological Well-Being (PWB) to distinguish it from SWB. They presented six different measurable approaches to human actualization to assess PWB, which also specify what promotes emotional and physical health: 1) autonomy; 2) personal growth; 3) self-acceptance; 4) life purpose; 5) mastery; and 6) positive relatedness (Ryff & Keyes, 1995).

The research literature on these two views of well-being overlap to some degree, despite differences in definition, and complement each other as they tend to ask different questions (Ryan & Deci, 2001). For example, Weich et al. (2011) found that lower eudaimonic well-being was more closely associated with unemployment than hedonic well-being was, and the former (but not the latter) was utterly confounded by the association between mental disorder and unemployment.

1.3 Mental well-being: An umbrella term

In this dissertation, mental well-being is used as an umbrella term for global self-esteem, body image, life satisfaction, anxiety, depression, and somatization, which are all specific components of mental health.

1.3.1 Self-esteem

Self-esteem constitutes a hierarchical construct (Figure 1), with global self-esteem at the top of the hierarchy and domain-specific self-esteem (describing self-satisfaction in specific areas) and sub-domains at lower levels (Fox, 1998; Rosenberg, Schooler, Schoenbach, & Rosenberg, 1995; Shavelson, Hubner, & Stanton, 1976). Global self-esteem is derived from individuals' self-evaluation in different domains and sub-domains in the hierarchy model of self-esteem. For example physical self-esteem (could also be called body image) in Figure 1 (level 2) is evaluated by both perceived competence (level 3 in Figure 1) and appearance (level 3 in Figure 1). It is, therefore, an evaluation of one's overall worthiness as an individual or "the positivity of the person's self-evaluation" (Baumeister, 1998, p. 684) and is a central parameter in assessments of mental well-being for all age groups (Rosenberg et al., 1995). Global self-esteem can indicate how individuals

view and manage challenges and changes in life (such as the rapid developmental change from adolescence to young adulthood), and how satisfied with life and themselves they have become (Kling et al., 1999). According to Rosenberg et al. (1995), the central feature of global self-esteem appears to be self-acceptance or self-respect. Global self-esteem is positively associated with body image (Siegel, Yancey, Aneshensel, & Schuler, 1999) and life satisfaction (Chow, 2005; Patel, Flisher, Hetrick, & McGorry, 2007). Low self-esteem has been linked to increased depression and anxiety (which often manifest as somatic complaints), the two most common comorbid disorders in adolescence and young adulthood (Afifi, 2007; Kinnunen, Laukkanen, & Kylma, 2010; Patel et al., 2007). This strong association found between self-esteem, and other mental well-being variables produces evidence supporting the comprehensive hierarchical construct that self-esteem is believed to be.

For several years researchers have shown substantial interest in the development and role of self-esteem in adolescence and adulthood (Kling et al., 1999). However, full consensus on how self-esteem develops from adolescence through young adulthood has not yet been reached. This is partly due to a lack of longitudinal studies covering that particular transition period (Erol & Orth, 2011).

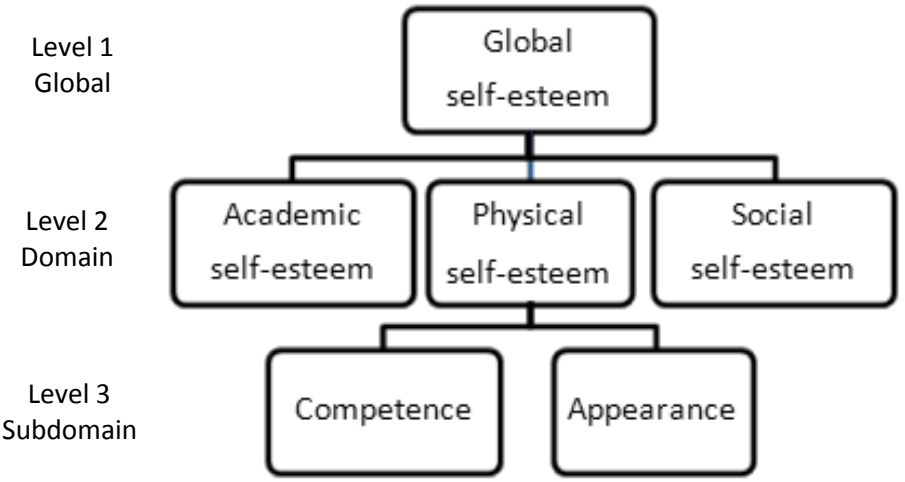


Figure 1. A hierarchy model of self-esteem with examples of domains and subdomains. Adjusted and modified from Fox (1998), Rosenberg et al. (1995), and Shavelson et al. (1976).

1.3.2 Body image

Body image dissatisfaction is subjective unhappiness with some or all aspects of one's appearance (Lawler & Nixon, 2011), and body image or physical self-

esteem is considered to be an important factor affecting global self-esteem (Fox, 1998; Rosenberg et al., 1995; Shavelson et al., 1976). Body image dissatisfaction has been linked with a range of adverse psychosocial consequences, including depression, eating disorders, obesity, and low self-esteem (Darby, Hay, Mond, Rodgers, & Owen, 2007; Stice, 2002; Wiederman & Pryor, 2000). Adolescence is a time of major developments in the physical and sexual maturity of individuals. During this transition period, both genders become more aware of their bodies. This awareness often leads to a comparison to others, both in function and appearance (Markey, 2010). Commonly accompanying physical development is the emergence of body dissatisfaction. The comparison to an "ideal" weight or shape presented in the media can also be a risk factor for becoming dissatisfied with one's body (Williamson, Gleaves, Watkins, & Schlundt, 1993). Western media has embraced the "thin ideal", where women are expected to be thin, tall and young, with at least moderately large breasts (Levine & Chapman, 2012), whereas the perfect body for men is supposed to be extremely lean and muscular (Cafri & Thompson, 2004).

According to Mellor, Fuller-Tyszkiewicz, McCabe & Ricciardelli (2010), public health systems in Western countries deal with a huge financial burden due to hospitalization resulting from body image dissatisfaction, for example, because of eating disorders. In addition, continued long-term psychological and physical care for patients who dislike their body (predominantly women) is needed. It has been proposed that society promotes an appearance culture, emphasizing the desirability of thinness with low body weight for women and a muscular physique for men (Lawler & Nixon, 2011). Moreover, Western cultures stigmatize obesity and overweight, where large bodies are regarded as undesirable for both genders (Grogan, 2006, 2008). Media pressure is also known to affect body image satisfaction among both genders (Hargreaves & Tiggemann, 2004). Likewise, studies on social network sites and body image, correlational studies on adolescent females, aged 13-18, have revealed a positive association between body dissatisfaction and time spent on social network sites (Tiggemann & Miller, 2010; Tiggemann & Slater, 2013). Studies have found body image and global self-esteem to be highly associated (Patel et al., 2007; Tiggemann, 2005; van den Berg, Mond, Eisenberg, Ackard, & Neumark-Sztainer, 2010). It has been reported that body image dissatisfaction is a risk factor for low self-esteem, independent of gender (Paxton, Eisenberg, & Neumark-Sztainer, 2006). Due to the strong relationship found between body image and global self-esteem, the former has been considered an important aspect of global self-esteem (Fox, 1988) and thereby important for overall mental well-being.

One important aspect of body image is the actual physical health of individuals. Physical activity (PA) plays a significant role in this relation as it is thought to influence healthy body image development in adolescents. The positive effect of PA on both physical and mental well-being is well documented (Blair, Cheng, & Holder, 2001; Kelly et al., 2011). High PA level has been found to be a strong predictor of higher levels of physical fitness in both adolescents (Haugen, Ommundsen, & Seiler, 2013; Sveinsson, Arngrimsson, & Johannsson, 2009) and adults (Physical Activity Guidelines Advisory Committee, 2008). However, very little is known about how these factors affect body image. Hakkinen et al. (2010) have highlighted the lack of evidence on the association between physical fitness and health-related quality of life (a person's perceived physical and mental well-being) in young adults. In adults, studies on the relationship between physical fitness and mental well-being have indicated an increase in overall wellness with good physical fitness (Hakkinen et al., 2010). Less is known about the association between fitness and body image, and, to our knowledge, nothing exists on the long-term effect of fitness on body image.

1.3.3 Life satisfaction

An increasingly important outcome measure in health sciences is the psychological construct of life satisfaction. It is an indicator of the overall quality of life concerning, for example, health, living standard, and support and is considered essential to overall well-being (George, 2002). Life satisfaction is often used synonymously with subjective well-being, quality of life or happiness (Daig, Herschbach, Lehmann, Knoll, & Decker, 2009). It shows the difference between desire, hope and, expectations in an individual's current state (patient or a healthy person) and can be assessed both globally or domain specifically, e.g., regarding family, relationships or work (Daig et al., 2009). Studies have indicated that the association between age and life satisfaction is U-shaped, i.e., individuals are most satisfied with life at younger and older life stages (Blanchflower & Oswald, 2008). Researchers have tried to find out which factors, e.g., personality, marital status, income, self-esteem, education, gender or age, affect life satisfaction the most (Diener, 2006). Results of studies have revealed marital status to be one of the most important factors affecting people's life satisfaction. That is, being married makes a person more satisfied with life than being single (Barrett, 1999; Diener, Sandvik, & Larsen, 1985; Holt-Lunstad, Birmingham, & Jones, 2008).

1.3.4 Anxiety, depression, and somatization

Anxiety, depression, and somatization have been identified as important public health problems. They affect a person's overall mental well-being and carry

high human, social and economic costs (Christensen, Davidsen, Kjoller, & Juel, 2014; Roth-Isigkeit, 2005). Anxiety, depression, and somatization are well-known psychological factors that share numerous symptoms and often co-occur (Nolen-Hoeksema, 2001). Persons with anxiety are described as being worried about future events and fearing current events, as well as being prone to brooding (American Psychiatric Association, 2013). Depression is common form of mood disorder portrayed by sadness, loss of interest or pleasure, disturbed sleep or appetite, feeling of tiredness and poor concentration (American Psychiatric Association, 2013). Depression can take over a person's emotions, bodily functions, behaviors and thoughts (Nolen-Hoeksema, 2001). Somatization describes a tendency to experience and communicate psychological distress in the form of physical complaints like headache, stomach pain, back or neck problems, fatigue symptoms and problems with sleep, which impact daily activities (Kinnunen et al., 2010).

1.4 Gender differences in mental well-being

The role of gender in mental health has attracted much attention in recent years (Afifi, 2007; Brugha et al., 2013; Kling et al., 1999; Kovess-Masfety et al., 2014; Vogt, 2014). Examination of gender differences in mental well-being refers to efforts to distinguish how different factors, and their interactions, affect the mental well-being of men and women, as well as exploring how gender inequality impacts health. Studies have revealed mixed results regarding gender differences in self-esteem during adolescence and young adulthood. Kling et al. (1999) conducted a large meta-analytic review of both cross-sectional and longitudinal data to establish whether there were any gender differences in global self-esteem. They found a small variation favoring men, but the most pronounced difference emerged in late adolescence between ages 15-18. This difference then decreased upon entering young adulthood (age 19-22).

Studies on body image, depression, anxiety and somatization have established clear gender differences favoring men. In Frost and McKelvie's (2004) cross-sectional study on body image, both adolescent boys and young men were more satisfied with their bodies than adolescent girls and young women. Not surprisingly, studies have shown that body image dissatisfaction in women is more strongly correlated with clinical eating disorders, whereas, in men, it has been associated with the use of anabolic steroids and food supplement abuse to gain weight (Mellor et al., 2010; Smolak, 2004). Body dissatisfaction is believed to initiate maladaptive eating behaviors and dieting that is often the start of an eating disturbance (Shroff & Thompson, 2006). It is also well documented that adolescent girls and young women have more

emotional problems than men, with more symptoms of anxiety, depression and somatic complaints (Aslund, Starrin, & Nilsson, 2010; Derdikman-Eiron et al., 2011; Kinnunen et al., 2010). Kinnunen et al. (2010) found more psychosomatic symptoms in women than men in both adolescence and early adulthood. They also revealed a stronger association for women than men between psychosomatic symptoms in adolescence and mental health symptoms in early adulthood. Gender differences for anxiety, depression, body image and somatization seem to persist even though they diminish through adulthood (Aslund et al., 2010; Kling et al., 1999). Studies on life satisfaction, however, indicate no gender differences in both adolescents and young adults (Blanchflower & Oswald, 2008; Diener & Diener, 1995). However, when facing difficulties, like serious accidents, women become more unsatisfied with life than men. On the other hand, women are more satisfied with life than men when experiencing something pleasant or beautiful (Diener, Sandvik, et al., 1985; Fujita, Diener, & Sandvik, 1991).

1.5 Physical activity, fitness, and mental well-being

In the literature physical activity, exercise and fitness are sometimes used interchangeably, which is often inappropriate (Castillo-Garzon, Ruiz, Ortega, & Gutierrez, 2006; Ortega, Ruiz, Castillo, & Sjostrom, 2008). Physical activity is defined as “any bodily movement produced by the skeletal muscles that results in a substantial increase in resting energy expenditure” (Bouchard, Blair, & Haskell, 2007). Exercise involves planned, structured, systematic and purposeful PA (Ortega et al., 2008). The concept of fitness, on the other hand, has evolved over the past three decades. It refers to a person's ability to finish daily activities without too much fatigue and, therefore, be able to enjoy leisure time activity (Malina, Bouchard, & Bar-Or, 2004).

There is not only strong evidence for the positive effects of PA on physical and cardiovascular health in people of all ages, but studies also indicate that regular PA improves sleep, reduces stress, and improves overall mental well-being (Ussher, Owen, Cook, & Whincup, 2007; Wijndaele et al., 2007). Review studies and meta-analysis support the positive effect of physical activity on mental well-being (McDonald & Hodgdon, 1991; Netz, Tenenbaum, & Sagiv, 1988; Rostad & Long, 1996; Spence, McGannon, & Poon, 2005). Furthermore, young people who exercise regularly are less influenced by external values, like making money, worrying about their looks and other social influence, than those who are physically inactive (Piko & Keresztes, 2006). Adolescents feel they are more popular among friends if they are physically active, and their self-image is usually better than the self-image of those who are inactive (Hausenblas & Fallon, 2006; Melnick, Vanfossen, & Sabo, 1988). A longitudinal

study examined whether different amounts of exercise affected the mental well-being of 14-year-olds over a one-year period. The results indicate that those who were physically active for one hour per day felt better mentally than those who were less active (Wiles et al., 2008). The same study showed that the girls were less active and felt worse mentally than the boys (Wiles et al., 2008). A few researchers have identified global self-esteem as the variable with the greatest potential to reflect the benefits of regular exercise on overall mental well-being. Sonstroem and Morgan (1989) even designed a model to explain the effects of physical activity on global self-esteem, the *Exercise and Self-Esteem Model* (EXSEM). It is hierarchically organized progressing from changes in physical performance and fitness to changes in self-esteem. At the bottom of the hierarchy is *exercise.* An alteration in exercise performance leads to changes in *physical self-efficacy* (i.e., modification in people's view of their ability to perform a certain exercise). This leads in turn to reformed *physical competence* (i.e., change in people's view of their own fitness), which, in turn, either directly affects *self-esteem* or goes through *physical acceptance* (i.e., creates a transformation in body acceptance) before affecting *self-esteem* (Martin Ginis, Strong, Arent, Bray, & Bassett-Gunter, 2014; Sonstroem & Morgan, 1989) (Figure 2). According to Martin Ginis et al. (2014), no explicit model or theory exists for guiding studies on exercise and body image. Therefore, some researchers (Lindwall & Lindgren, 2005; Martin Ginis, Bassett-Gunter, & Colin, 2012) have turned to Sonstroem and Morgan's (1989) *Exercise and Self-esteem Model* (Figure 2) as a framework for designing studies and testing the relation between physical activity and body image.

The increases seen in overweight and obesity among young people today depend not only on lack of exercise, but also on environmental, metabolic and genetic factors (Wyatt, Winters, & Dubbert, 2006). Being overweight predisposes individuals for teasing, social rejection, and other negative treatment, as well as being stereotyped as lazy and incompetent (Puhl & Latner, 2007). The association between body fat and mental well-being is still unclear, and studies have given mixed results (Friedman & Brownell, 1995; Jorm et al., 2003; McElroy et al., 2004; Ozmen et al., 2007; Swallen, Reither, Haas, & Meier, 2005). However, being overweight and thereby (in most cases) unfit, has been related to body image dissatisfaction (Barker & Galambos, 2003), low physical self-esteem (Welk & Joens-Matre, 2007), and low global self-esteem (Wang & Veugelers, 2008). Studies have also indicated that adults who were overweight as adolescents (body mass index ≥ 25) were much likelier to have a worse mental health than normal-weight adolescents (Hermann, Hopman, & Craig, 2010).

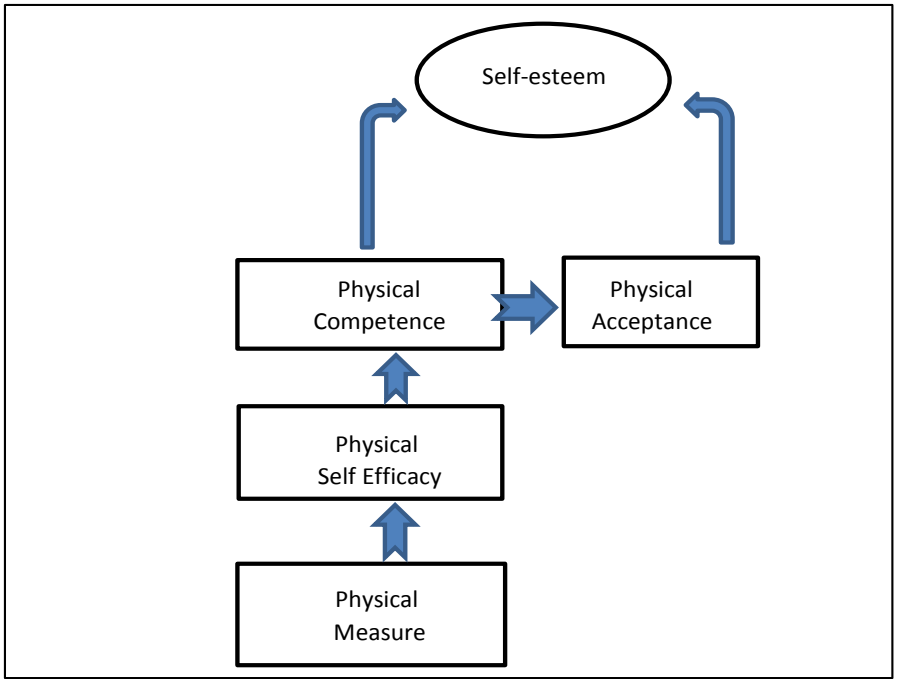


Figure 2. The Exercise and Self-Esteem Model (Sonstroem & Morgan, 1989) examines the effect of changing exercise (physical measure) on self-esteem.

Physical fitness has sometimes been referred to as the golden standard of measures on physical activity (Ainsworth, 2009). It can be viewed as an integrated measure of many, if not all, functions of the body involved in daily physical activity (Ortega et al., 2008). Garber et al. (2011) point out that physical fitness has been operationalized as a measurement of skills that include cardiorespiratory fitness (CRF), muscular strength, endurance, body composition, balance, flexibility, agility, power and reaction time. Physical fitness has been found to be a strong predictor of mortality (Blair et al., 2001; Myers et al., 2004; Williams, 2001). It has also been associated with less body fat (Grund et al., 2000) and more physical activity (Dencker et al., 2006) in all age groups. Due to this comprehensiveness, physical fitness is considered "a powerful marker of health" (Ortega et al., 2008, p. 1). According to Ortega et al. (2008), fitness is partly determined genetically but is influenced by other factors. One of the most important of these is physical activity.

In assessments of fitness, researchers have focused their attention more on health-related aspects of fitness (i.e., CRF) and less on performance-related aspects of physical fitness (Bouchard et al., 2007). The most accurate direct measure of CRF is the measurement of maximal oxygen uptake (VO_{2MAX}), which

is defined as the highest rate at which a person consumes oxygen at maximum exercise effort (Jurca et al., 2005). Since very sophisticated technology and knowledge is needed to measure CRF with $VO_{2MAX,}$ other indirect, less invasive and less costly methods have been used—like the one used in this study: the maximal multi-stage cycle ergometer exercise test.

Results from studies on physical fitness have shown that having poor physical fitness during adolescence increases the risk of being obese as an adult (Eisenmann, Wickel, Welk, & Blair, 2005). Furthermore, results from studies on physical fitness have suggested that being physically fit is an even better indicator of good health than normal weight (Mora et al., 2003). It can, therefore, be inferred that individuals with poor physical fitness are at higher risk of dying from health-related risk factors than those with good fitness, independent of their body weight or body mass index (BMI) (Mora et al., 2003). In adults, studies on the association between physical fitness and mental health have indicated an increase in overall wellness when one's fitness is good (Hakkinen et al., 2010). They have also suggested that improvement of CRF (with intensive physical activity) is required for enhanced mental well-being (Ortega et al., 2008). To our knowledge, there is a shortage of studies on the association between objectively measured physical fitness and mental well-being in adolescents and young adults.

A vast literature shows a worldwide increase in obesity among people of all ages (Ebbeling, Pawlak, & Ludwig, 2002; Welch, Ariza, Wieczorek, & Binns, 2008). Children, adolescents and young adults in Iceland are no exception, for they get insufficient exercise, and their weight has increased (Briem, 1999; Johannsson, Arngrimsson, Thorsdottir, & Sveinsson, 2006; Sveinsson et al., 2009). Parallel to this worldwide increase in obesity and physical inactivity, both physical health and mental well-being have declined in young people (Biddle & Asare, 2011; World Health Organization, 2006). Studies have shown that being physically active leads to a healthier lifestyle and increases overall well-being (Fox, 1999). The World Health Organization (World Health Organization, 2004a) and the Icelandic Ministry of Health (2008) have even aimed at increasing young people's physical activity in an effort to boost their mental well-being. The prevalence of overweight and obesity in adolescents and young adults, their lack of exercise, and worsening mental health are presumably the greatest health and well-being concerns of the 21st century. Physical activity can heavily influence these health parameters and this deterioration in health parameters (Gore et al., 2011; World Health Organization, 2004b).

1.5.1 Gender differences in physical activity, fitness and association with mental well-being

The benefits of physical activity are clearly demonstrated, as can be seen from the above discussion of the literature. However, do females' and males' mental well-being benefit differently from exercise? Less is known about this as few investigations have included comparisons across gender (Asci, 2009). The few studies on the association that analyze gender differences reveal mixed results. Asci's study (2009), for example, looked at the effect of a 10-week exercise program on university students' self-concept. The study included items on self-criticism, (personal self, family self, moral/ethical self, social self, physical self, identity, and self-satisfaction), trait anxiety, and belief in external control. The results from Asci's study showed that females and males did not differ in improvement on trait anxiety, belief in external control and most dimensions of self-concepts. The only differences found between the genders were in personal self and physical self (i.e., body image), where men improved more than women. Galper, Trivedi, Barlow, Dunn and Kampert (2006) analyzed the effect of PA on depression in adults and found no gender difference in the association between the two variables. However, Bhui and Fletcher (2000) established a gender difference in the association between anxiety, mood and PA, where the dose of PA and mood improvement was significant for men only.

2 Aim of the study

Based on the literature overview above, the following seems evident: a) during the period from adolescence to young adulthood, lifestyle patterns form, and these patterns tend to be stable throughout the rest of life; b) parallel to decreased PA and worsening physical fitness, mental well-being has declined; and c) body image can act as an important influential factor for global self-esteem and thereby overall mental well-being. Based on these associations, it could be hypothesized that by fostering a good body image (for example through fitness), one could protect/support the mental health of individuals, with the added benefit of supporting physical health. Although many studies in recent decades have focused on the relation between physical activity and mental well-being, few of them have been longitudinal, examining the changes in mental well-being from adolescence to young adulthood. Moreover, many of them use subjective measures of physical activity or participants' perceived status of physical fitness. Even fewer longitudinal studies exist which focus on the association between physical fitness and mental well-being from adolescence to adulthood, a period when the foundation of future physical and mental well-being is laid.

Hence, the main aim of this dissertation is to study longitudinal changes in mental well-being from adolescence to young adulthood and to examine the association of fitness and PA with mental well-being.

The main aim of the dissertation will be met by focusing on four specific aims which the following research questions address:

1. Are there gender differences in changes of mental well-being from age 15 to age 23? (Paper I)
2. Is the association between body image and physical activity and fitness different across gender and age? (Paper 2)
3. Does fitness, measured both objectively and subjectively, at age 15 predict body image at age 23? (Paper 3)
4. Does body image mediate the association between aerobic fitness and self-esteem? (Additional results)

3 Material and Methods

3.1 Study design

During the academic year 2003-2004, two cohorts, individuals born in 1988 and 1994, were recruited to participate in a large cross-sectional study on the lifestyle of Icelandic children, “The Lifestyle of 9- and 15-year-old Icelanders”. Eight years later a follow-up study with the same participants was entitled “The physical, mental and a social attainment of young Icelanders”. These baseline and follow-up studies included various measurements of, e.g., physical condition, mental well-being, and social factors. Both studies were a part of the European Youth Heart Study (EYHS) and followed the EYHS measurement protocol. The empirical investigations included in this dissertation are based on these two studies. The baseline study was conducted between August 2003 and January 2004, and the follow-up was carried out between August 2011 and January 2012. This dissertation focuses on the older cohort, which was age 15 at baseline and age 23 at follow-up. The longitudinal design of the current study has the advantage of giving researchers the opportunity to track changes over time as subjects are measured more than once over a long period.

3.2 Subjects

In an effort to represent the true population of rural and urban areas in Iceland, 18 schools in the vicinity of Reykjavik, the capital, and from the North and East regions of Iceland (Akureyri, Húsavík, Egilsstaðir) (Figure 3) were randomly selected, based on the national and geographical distribution of the Icelandic population, and invited to participate in the baseline measurements. Sixty percent of the participants came from the Reykjavik area, 35% came from smaller towns and 5% represented the the rural area in Northeast Iceland (Magnusson, Arngrimsson, Sveinsson, & Johannsson, 2011). Baseline measurements were conducted in the participants' schools, but follow-up measurements were taken at health clinics in North and East Iceland (Akureyri, Húsavík, Egilsstaðir). In Reykjavik, measurements took place at the lab of the Icelandic Heart Association.

At baseline, 67.9% of female and 74.4% of male participants lived with both parents, 17.9% of females and 14.9% of males lived with a single parent. At follow-up, 15.2% of female participants and 11.9% of the male participants

lived alone, while 29.4% and 46.8% of participants (females and males, respectively) lived with a spouse, and 18.5% of females and 14.7% of males lived with their child/children. At follow-up, 75.2% of the females and 62.3% of the males were attending secondary school or higher education.

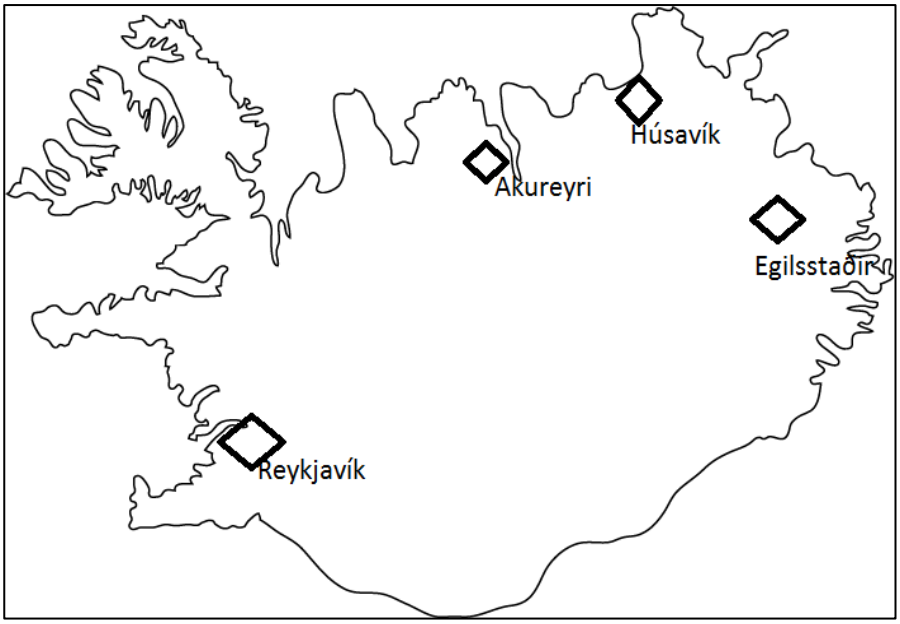


Figure 3. Participants represented both urban and rural parts of Iceland.

3.3 Ethics

Written informed consent was obtained from participants and their parents before the baseline measurements were taken. Prior to participation in the second round of data collection, informed consent was obtained from the participants. Strict procedures were followed to ensure confidentiality; the participants were paired with their code number which they had received from the baseline measurements. The research project was approved by the Icelandic Data Protection Authority according to the Icelandic Act on Processing of Personal Data and the Icelandic Bioethics Committee (VSNa2003060014/03-12/BH/--).

3.4 Dropout

A total of 443 individuals were measured objectively at baseline (age 15), of which 385 answered the questionnaire, which constitutes an almost 10% of the national population (N= 4168) in that age group (Statistics Iceland, e.d.). Eight years later 333 of the baseline participants were located and contacted,

of which a total of 201 subjects participated at follow-up, completing objective measures and answering the questionnaire again at the age of 23. Total dropout was 47.8% with more women dropping out than men (Figure 4).

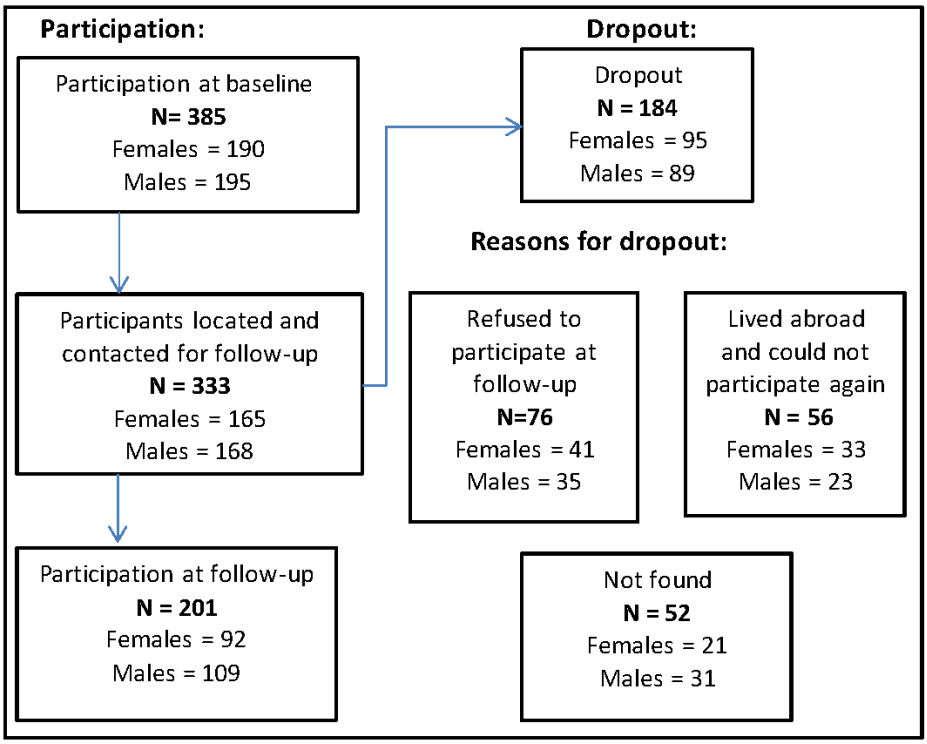


Figure 4. Participation at baseline (age 15) and follow-up (age 23) and reasons for dropout from the study.

3.5 Measurements

The questionnaire in this study included validated sources and was coordinated with the study Health behavior in school-aged children (HBSC), by using several key questions which link together the EYHS and the Icelandic HBSC questionnaires. The objective measures used in this study were height, weight (to calculate BMI), skinfold thickness, physical activity and aerobic fitness. Questions from the questionnaire used in this study assessed global self-esteem, life satisfaction, body image, anxiety, depression, and somatic complaints. At follow-up, the questionnaire also contained questions on parents' education which were used to assess the participants' socioeconomic status (SES). Table 1 gives an overview of how many participants finished each measurement used, both at baseline and follow-up.

Table 1. Number of participants finishing each measurement at baseline and follow-up.

	15 year-olds			23 year-olds		
Part of study	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Questionnaire	190	195	385	92	109	201
Body mass index	215	228	443	92	109	201
Fitness	114	122	236	79	102	186
Skinfold -thickness	215	228	443	92	109	201
Physical Activity	81	92	173	69	79	148

3.5.1 Self-esteem

Global self-esteem was assessed at both time points, using the Rosenberg Self-Esteem Scale (Rosenberg, 1965). The scale consists of ten statements, each rated as negative or positive, with four response options ranging from “strongly agree“ (3) to “strongly disagree“ (0). Higher scores (15 points or higher) reflect a higher level of self-esteem. The Rosenberg scale has been widely used in measuring self-esteem in young people, and its reliability and validity are well documented (Kling et al., 1999; Paxton et al., 2006; Schmitt & Allik, 2005). Cronbach’s alpha was used to evaluate internal consistency, which was $\alpha = 0.89$ for baseline measurements and $\alpha = 0.91$ at follow-up measurements.

3.5.2 Body image

Body image was evaluated at both time points with five questions from the Body and Self-Image subscale of the Offer Self-Image Questionnaire (OSIQ) (Asgeirsdottir, Ingolfsdottir, & Sigfusdottir, 2012; Offer, Ostrov, Howard, & Dolan, 1992). Participants were asked how well they agreed with the following five statements: “I’m satisfied when I think about how my body will look in the future“, “I usually think I’m unattractive and not good looking”, “I’m satisfied about how my body looks”, “I’m satisfied with the changes that my body has undergone in the last few years”, and “I feel strong and healthy”. All items were rated on a four-point response scale, where 1 = Not at all true of me, and 4 = True of me. Higher scores reflect a better body image. Total scores on this version of the scale ranged from 5 to 20 points. Cronbach’s alpha for body image scores at baseline was $\alpha = 0.79$ and $\alpha = 0.80$ at follow-up.

3.5.3 Life satisfaction

Life satisfaction was measured in two ways. At baseline, it was measured with only two questions/statements from Diener's Satisfaction with Life Scale (SWLS) (Diener, Emmons, Larsen, & Griffin, 1985): “I’m satisfied with my life” and “In most ways my life is close to my ideal”. There were only four response options for these two

questions (there are seven in the SWLS), “not at all true of me“ (1) to “very true of me” (4). At the follow-up measurements (age 23), life satisfaction was assessed with the full SWLS scale, which contains five statements designed to measure global cognitive judgments of one’s life satisfaction (Diener, Emmons, et al., 1985). Participants indicate how much they agree or disagree with each of the five items, rating each statement on a seven-point scale ranging from ”strongly disagree“ (1) to ”strongly agree“ (7). Since the response options were not the same at baseline and follow-up for the two questions used from the SWLS, the response options at follow-up for these two questions were grouped into four categories to enable comparison. To compare the development of life satisfaction from 15 to age 23, the two questions (from baseline) indicated above with four response options were used. For these two questions, a healthy score was defined as a score above five points. However, the standardized SWLS with seven response options was used to assess life satisfaction in men and women at age 23. A healthy score on SWLS was a score above 20 points. In this study, Cronbach’s alpha at baseline was $\alpha = 0.90$ and at follow-up $\alpha = 0.83$ (for two items) and $\alpha = 0.88$ (for all five items in SWLS).

3.5.4 Anxiety, depression, and somatization

Subscales of the Symptom Checklist 90 (SCL-90) (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974) were used to measure anxiety (4 items), depression (10 items), and somatization (8 items) at both time points. They were scored on a five-point Likert-scale rated from 1 (almost never) to 5 (almost always), asking about feelings of anxiety, depression and somatic complaints in the preceding week. Examples of questions are “Were you nervous” for anxiety, “Did you feel that the future is hopeless” for depression, and “Did you have a headache” for somatization. A healthy score for anxiety was below 12 points; for depression, scores below 30 points were considered healthy, and scoring below 24 points on the somatic complaint scale is considered a healthy score. Cronbach’s alpha for baseline anxiety, depression, and somatization was $\alpha = 0.74$, $\alpha = 0.89$, and $\alpha = 0.78$, respectively, and $\alpha = 0.59$, $\alpha = 0.88$ and $\alpha = 0.74$ at follow-up, for these same variables. Cronbach's alpha for anxiety at follow-up was the only unsatisfactory internal consistency level among the mental well-being measurements.

3.5.5 Physical activity

Participants’ PA was assessed using Actigraph activity monitors (Manufacturing Technologies Inc. (MTI)) model GT3X; these monitors are also able to measure sedentary behavior. Participants carried the monitor on their right hip for one week from the time they woke up until they went to sleep. Data presented in this study is the total time (minutes per day) from weighted average of weekdays and weekend days spent in moderate-to-vigorous activity (threshold

2000 counts per minute (cpm) for age 15, and 2020 cpm for age 23). A detailed protocol for measurements with accelerometers has been described previously (Magnusson, Sveinsson, Arngrimsson, & Johannsson, 2008). This particular type of accelerometer gives a reliable and valid measure of PA (Brage, Wedderkopp, Franks, Andersen, & Froberg, 2003), but is unable to measure all types of activity, e.g., swimming.

3.5.6 Fitness

The objective measure of physical fitness (CRF) was conducted using the maximal cycle ergometer test on a Monark 839E bike (Monark Exercise AB, Vansbro, Sweden). It is an indirect test of VO2max, which was developed in Odense, Denmark by Hansen, Froberg, Nielsen, and Hyldebrandt (1989). Each participant cycled at a predetermined workload (Watts or W): 40 W for women and 50 W for men, which increased every three minutes until voluntary exhaustion was reached or until pedal rate of 40 rpm could not be maintained. The participants were advised that they could quit the test at any time but were verbally encouraged to give their best effort and bike as long as they possibly could, and during the last 15 seconds of every stage (every time before the workload increased) the participants' rating of perceived exertion was obtained on Borgs' scale, ranging from 5 (very easy to bike) up to 20 (exhaustion) (Borg, 1998). Maximal power output per unit of body weight (Wattsmax * kg-1) is calculated for each participant and used as an indicator of CRF to compare results. This test has been validated for adolescents and adults (Arngrimsson, Sveinsson, & Johannsson, 2008; Eisenmann, 2007). Blood pressure was measured before the bike test and individuals were advised not to take the test if their blood pressure was too high. During each test, heart rate was measured with a Polar heart rate (HR) monitor (Polar Vantage, Polar Electro, Kempele, Finland). Total cycling time was measured in seconds with a stopwatch. Participants “passed” the CRF test if two out of three criteria were met: a) heart rate was not lower than 5% of max heart rate for the age group; b) rate of the participants' perceived exertion was 19 or more on Borg's scale; or c) a researcher's subjective evaluation of exhaustion.

Self-reported fitness, the subjective measure of fitness, was estimated with the following question from the questionnaire, “*How good is your fitness*?”, with four response options: 1 = bad; 2 = okay; 3 = good; and 4 = excellent. This question has previously been used in the *Health behavior in school-aged children* (HBSC) study, which is a cross-national study. It has for the last 30 years aimed at gaining insight into young people’s well-being and is supported by the World Health Organization (HBSC, e.d.).

3.5.7 Body composition

Body composition was estimated with body mass index (BMI) and skinfold thickness. BMI was calculated from participants' weight and height (kg/m2). Standing height and body weight were measured according to standard procedures as described by Johannsson et al. (2006). Height was measured to the nearest 0.1 cm with a stadiometer (Seca model 217, Seca Ltd. Birmingham, UK), and body weight was measured on a balance scale (Seca model 813, Seca Ltd. Birmingham, UK.) to the nearest 0.1 kg, with participants wearing light clothes.

Skinfold thickness was measured with a Lange skinfold caliper (Lange, Beta Technology Incorporated, Cambridge, Maryland) in four places on the left side of the body (subscapular, triceps, biceps, and suprailiac). All skinfold measurements in each place were taken three times, the mean value of the two closest measurements was calculated, and the sum of four skinfolds (mm) was used for analysis. The same trained personnel performed all measurements at all times for each of the two studies (baseline and follow-up).

3.6 Statistics

The papers present descriptive summaries as means and standard deviations (SD) for continuous variables and as frequencies and percentages for categorical variables. Study variables were examined for distributional properties. The alpha level for significant differences was set at 0.05. The criteria used for assessing the Goodness of Fit in the structural equation models (SEM) was the same as Geiser (2013) recommends for acceptable fit: Comparative Fit Index (CFI) should be larger than 0.95; Root Mean Square Error of Approximation (RMSEA) should be smaller than 0.05; and Standardized Root Mean Square Residual (SRMR) should be smaller than 0.08. Little (2013) gives a rule of thumb for interpreting the CFI as poor fit when CFI < 0.85; a mediocre fit when CFI is 0.85-0.90ish; Acceptable fit when CFI is 0.90-0.99ish and a very good fit when CFI is 0.95-0.99ish and; outstanding fit when CFI > 0.99ish.

3.6.1 Paper 1

A mixed model ANOVA for repeated measures was carried out to measure gender difference and longitudinal changes in mean scores for each mental well-being variable. If the interaction between gender and age was significant ($p < 0.05$), a Tukey post hoc test was used to compare different pairs of means. Since life satisfaction was measured with the SWLS only at the follow-up (vs. measured with only two questions from the SWLS at baseline), an unpaired t-test was used to test for difference in life satisfaction between gender at follow-up. Possible differences in mental well-being variables between the

dropouts and non-dropouts were analyzed using the unpaired t-test (which revealed no differences in scores at baseline between those who dropped out and non-dropouts, independent of gender).

3.6.2 Paper 2

Structural equation modeling (SEM) analysis was conducted to analyze the data in paper 2. SEM was used to evaluate the influence of PA, aerobic fitness and self-reported fitness on body image across age and gender. Covariates tested in the models were BMI, skinfold thickness, depression and anxiety at both time points and SES only at age 23. Body image, anxiety, and depression were all handled as latent variables (instead of using only their means scores). SEM allows explicitly taking errors of measurement for latent variables into account and thereby avoiding bias in parameter estimates and standard errors (Geiser, 2013). The fit of the proposed structural model to the observed data was tested across genders at both time points (Table 2).

Table 2. The fit statistic for proposed structural model.

	Females age 15	Males age 15	Females age 23	Males age 23
RMSEA	0.095	0.070	0.111	0.092
CFI	0.899	0.093	0.879	0.923
SRMR	0.052	0.054	0.069	0.055

RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Square Residual.

The model included latent variables for body image (five items), depression (10 items), and anxiety (four items), and the following observed variables: aerobic fitness, self-reported fitness, SES, PA, BMI, and skinfold thickness. The latent variables are factors from a confirmatory factor analysis of the measured variables from the questionnaire. The relationship between a latent variable and a measured variable is expressed as factor loadings and can be seen in table 3. Fit statistics for the test of measurement invarince of variables across time was calculated in accordance with Little (2013) can be viewed in table 4. According to Cheung & Rensvold (2002) if the change in CFI (ΔCFI) from configural factorial invariance model to weak factorial invaraince model is not more than 0.01 the invariance holds.

In the first step of the SEM analysis, body image was regressed on the primary observed variables (i.e., aerobic fitness, self-reported fitness, and PA). In the second step of the SEM analysis, the above-mentioned covariates were included in the regression. Maximum likelihood was used for parameter estimation.

Table 3. Factor loadings for latent variables used in the structural model.

	Female		Male	
	Age 15	**Age 23**	**Age 15**	**Age 23**
Body image				
Item 1	0.592	0.597	0.477	0.726
Item 2	0.748	0.555	0.488	0.507
Item 3	0.733	0.867	0.766	0.784
Item 4	0.534	0.646	0.757	0.738
Item 5	0.572	0.594	0.664	0.677
Depression				
Item 1	0.780	0.717	0.663	0.653
Item 2	0.316	0.593	0.652	0.554
Item 3	0.692	0.674	0.772	0.748
Item 4	0.769	0.725	0.717	0.566
Item 5	0.496	0.590	0.549	0.320
Item 6	0.909	0.883	0.802	0.882
Item 7	0.784	0.822	0.665	0.785
Item 8	0.666	0.692	0.614	0.658
Item 9	0.749	0.745	0.622	0.849
Item 10	0.555	0.357	0.679	0.430
Anxiety				
Item 1	0.566	0.068	0.494	0.276
Item 2	0.701	0.706	0.707	0.652
Item 3	0.749	0.462	0.639	0.705
Item 4	0.580	0.824	0.597	0.716

Table 4. Fit statistic for test of measurement invariance for body image, depression, anxiety and self-esteem.

	χ^2	df	p	CFI	ΔCFI	RMSEA	SRMR
Female							
Model 1 Body image	36.4	28	0.132	0.977		0.039	0.058
Model 2 Body image	44.3	32	0.070	0.967	0.010	0.044	0.096
Model 1 Depression	249.2	157	0.001	0.936		0.054	0.079
Model 2 Depression	280.9	166	0.001	0.921	0.015	0.060	0.101
Model 1 Anxiety	8.9	15	0.881	1.000		0.000	0.045
Model 2 Anxiety	44.2	18	0.001	0.881	0.119	0.086	0.106
Model 1 Self-esteem	231.5	153	0.001	0.954		0.051	0.072
Model 2 Self-esteem	240.2	162	0.001	0.954	0	0.049	0.081
Male							
Model 1 Body image	47.5	29	0.017	0.957		0.056	0.072
Model 2 Body image	51.2	33	0.023	0.958	0.001	0.052	0.085
Model 1 Depression	231.2	151	0.001	0.944		0.051	0.080
Model 2 Depression	358.3	158	0.001	0.887	0.057	0.071	0.108
Model 1 Anxiety	24.2	14	0.040	0.958		0.060	0.052
Model 2 Anxiety	40.6	17	0.001	0.904	0.054	0.082	0.093
Model 1 Self-esteem	239.1	153	0.001	0.951		0.053	0.067
Model 2 Self-esteem	260.8	162	0.001	0.943	0.008	0.055	0.083

Model 1 = Configural model; Model 2 = Weak invariance model; df = degrees of freedom; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Square Residual; ΔCFI = difference between model 1 and model 2.

3.6.3 Paper 3

A paired t-test was used to analyze changes in scores from age 15 to age 23 for all variables except self-reported fitness. There Kendall's Tau b was calculated for the four categories. One-way ANOVA was used to analyze differences in mean aerobic score between each of the four categories of self-reported fitness, and post-hoc test Tukey (HSD) was used to examine significant differences between categories. A structural equation model analysis was applied to analyze the data. Cross-lagged SEM was used to evaluate the influence of the manifest variables (aerobic fitness and self-reported fitness, measured at age 15) on the latent variable (body image, measured at age 23). Covariates tested in the model were the following: gender (0 = females, 1 = males), BMI and PA at age 15 and SES at

age 23. In the measurement model, the latent variables (body image at age 15 and 23) are factors from a confirmatory factor analysis of the five measured variables (five manifest variables on body image) from the questionnaire. The relationship between a latent variable and a measured variable is expressed as factor loadings (Table 5).

Table 5. Factor loadings for body image at age 15 and age 23.

	Participants	
	Age 15	**Age 23**
Body image		
Item 1	0.506	0.627
Item 2	0.611	0.498
Item 3	0.799	0.824
Item 4	0.677	0.708
Item 5	0.610	0.649

Main variables in the cross-lagged model, i.e., fitness and body image, were regressed on covariates in accordance with Little (2013) (as SES was only measured at follow-up, it was considered a covariate for variables measured at follow-up). The analyses of the measurement model and the cross-lagged structural model were conducted simultaneously, and maximum likelihood was used to deal with missing values. The cross-lagged SEM, analyzing the longitudinal predictor-outcome relationship between both fitness variables measured at age 15 and body image measured at age 23, had the following Goodness-of-fit indices: RMSEA = 0.061; CFI = 0.854; SRMR = 0.081.

3.6.4 Additional results

A mixed model ANOVA for repeated measures was carried out to measure gender difference and longitudinal changes in PA, aerobic fitness, BMI, and skinfold thickness. If the interaction between gender and age was significant ($p < 0.05$), a Tukey post hoc test was used to compare different pairs of means.

The *Exercise and Self-Esteem Model* was used as a reference when analyzing the hypothesized mediational model of the relation between fitness and self-esteem through body image across age. Mediational structural equation modeling was used to analyze the data, and the measurement model and structural model were analyzed simultaneously. The factor loadings for the latent variables of body image and self-esteem for both genders at both time points can be viewed in table 6. SEM yields a comprehensive approach of mediation testing by allowing direct effects, indirect effects, and standard errors

to be estimated simultaneously. In the test of mediation (the indirect effects), we calculated asymmetric bootstrapped confidence intervals and examined whether they contained 0 or not. According to Geiser (2013), an indirect effect is significant at the 0.05 level if the value 0 is not part of the 95% bootstrap confidence interval around the indirect effect. For higher precision, 10,000 bootstrap samples were taken, and a bias-corrected version of the bootstrap was done as recommended by MacKinnon, Lockwood, and Williams (2004). The fit statistic for the mediation model for adolescent females had the following fit indices: CFI = 0.848; RMSEA = 0.109; and SRMR = 0.057. For adolescent males the fit statistic for the mediation model showed lack of fit CFI = 0.741; RMSEA = 0.131; and SRMR = 0.095. By allowing two correlations between four factors representing self-esteem the fit indices for the model improved to CFI = 0.908; RMSEA = 0.080 and SRMR = 0.085. Fit indices of the mediational model for females in their young adulthood were: RMSEA = 0.112; CFI = 0.846; SRMR = 0.078. Fit indices of the mediational model for males in their young adulthood were: RMSEA = 0.097; CFI = 0.888; SRMR = 0.080. Table 4 shows fit statistics for testing the measurement invariance of variables across time.

Table 6. Factor loadings for latent variables in mediation model.

	Females		**Males**	
	Age 15	**Age 23**	**Age 15**	**Age 23**
Self-esteem				
Item 1	0.749	0.792	0.694	0.821
Item 2	0.792	0.773	0.768	0.712
Item 3	0.757	0.759	0.556	0.799
Item 4	0.655	0.778	0.651	0.783
Item 5	0.567	0.294	0.84	0.490
Item 6	0.827	0.895	0.862	0.816
Item 7	0.839	0.808	0.816	0.778
Item 8	0.573	0.574	0.280	0.556
Item 9	0.707	0.586	0.591	0.813
Item 10	0.668	0.686	0.541	0.801
Body image				
Item 1	0.610	0.568	0.548	0.738
Item 2	0.722	0.578	0.523	0.518
Item 3	0.748	0.810	0.724	0.767
Item 4	0.508	0.686	0.735	0.716
Item 5	0.598	0.636	0.667	0.669

All SEM analyses were conducted with M*plus* software version 7 (Muthén & Muthén, 1989). Comparisons between dropouts and non-dropouts were calculated with Microsoft Excel 2010. Other analyses were calculated using SAS Enterprise Guide, version 7.1 (SAS Institute Inc., Cary, NC).

4 Results

4.1 Changes in mental well-being

The characteristics of the participants' mental well-being at baseline (age 15) and follow-up (age 23) are shown in table 7. Females' self-esteem increased from age 15 to age 23 (Tukey post hoc: $p < 0.001$), but no difference was found for the same period for males. Participants' anxiety score decreased from age 15 to age 23 ($F(1, 181) = 4.0$, $p = 0.04$), independent of gender, and their somatic complaints became fewer ($F(1, 181) = 14.8$, $p < 0.001$). Life satisfaction (measured with two items) decreased, independent of gender ($F(1, 181) = 32.4$, $p < 0.001$), but men's and women's body image and depression scores from adolescence to young adulthood (Table 7) showed no change.

Table 7. Mean score (standard deviation) for mental well-being variables and p-values from mixed model ANOVA.

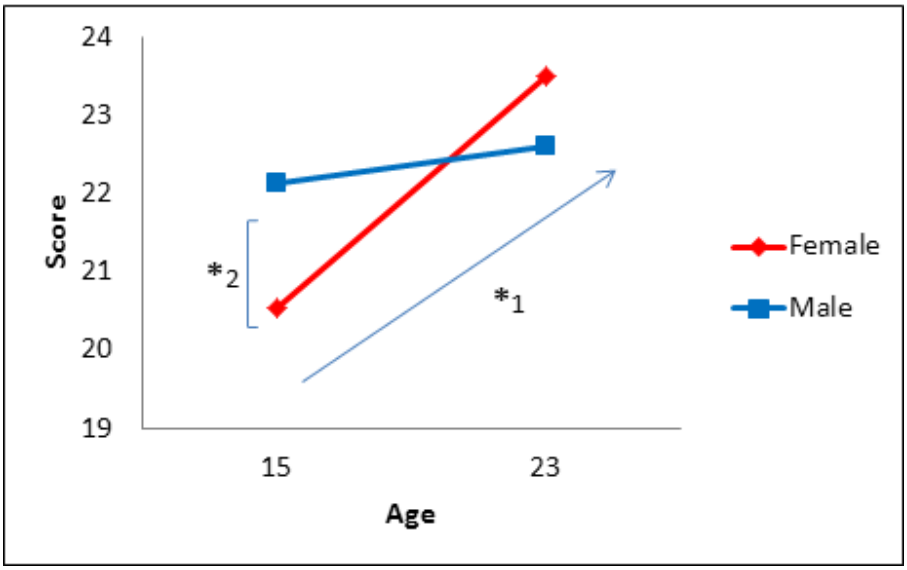
	Females		Males		Gender	Age	Interaction
Variables	Age 15	Age 23	Age 15	Age 23	p-value	p-value	p-value
Self-esteem	20.55 (6.04)*	23.49 (5.15)	22.13(5.68)*	22.60 (6.00)	0.46	<0.001	0.004
Life satisfaction+	6.55 (1.38)	6.18 (1.03)	6.62 (1.40)	5.87 (0.98)	0.36	<0.001	0.09
SWLS		26.44 (4.93)‡		24.09 (5.80)‡			
Body image	14.06 (2.79)*	14.78 (2.48) ‡	15.39 (2.72)*	15.42 (2.66) ‡	<0.001	0.10	0.11
Anxiety	7.04 (2.98)*	6.39 (2.08) ‡	5.70 (2.33)*	5.52* (2.01) ‡	<0.001	0.04	0.29
Depression	17.31 (6.94)*	16.09 (6.14) ‡	14.50 (5.80)*	14.69 (5.15) ‡	<0.001	0.40	0.14
Somatic complaints	16.34 (5.58)*	14.26 (4.71) ‡	13.97 (4.80)*	13.30 (4.40) ‡	<0.001	<0.001	0.07

* = Gender differences in scores at age 15, $p < 0.05$; ‡ = Gender differences in scores at age 23, $p < 0.05$.
SWLS = Satisfaction with Life Scale, only used at follow-up; + = only two items from SWLS used.

4.1.1 Gender differences in mental well-being

The only gender difference found in the changes of mental well-being from adolescence to young adulthood was for self-esteem, i.e., age-gender interaction (Figure 5). During the eight-year period between measurements, young women increased their mean score for self-esteem more than young men ($F(1, 182) = 8.4$) for interaction, $p = 0.004$ (Table 7). The results show that adolescent boys had more self-esteem than adolescent girls at age 15 (Tukey post hoc: $p = 0.03$), but no gender difference for self-esteem was found in participants when they had reached 23 years of age (Tukey post hoc: $p = 0.72$). A score below 15 points was

classified as “low self-esteem”, and at the age of 15, 9.7% of the boys vs. 14.5% of the girls fell into this category. As 23 year olds, 11.1% of men had low self-esteem, while the same applied to only 3.3% of the women (Figure 6).



*1 = females’ self-esteem increased more than men’s.
*2 = males had higher self-esteem than women at age 15. No difference was found at age 23. ($p < 0.05$).

Figure 5. Interaction (gender and age) for self-esteem.

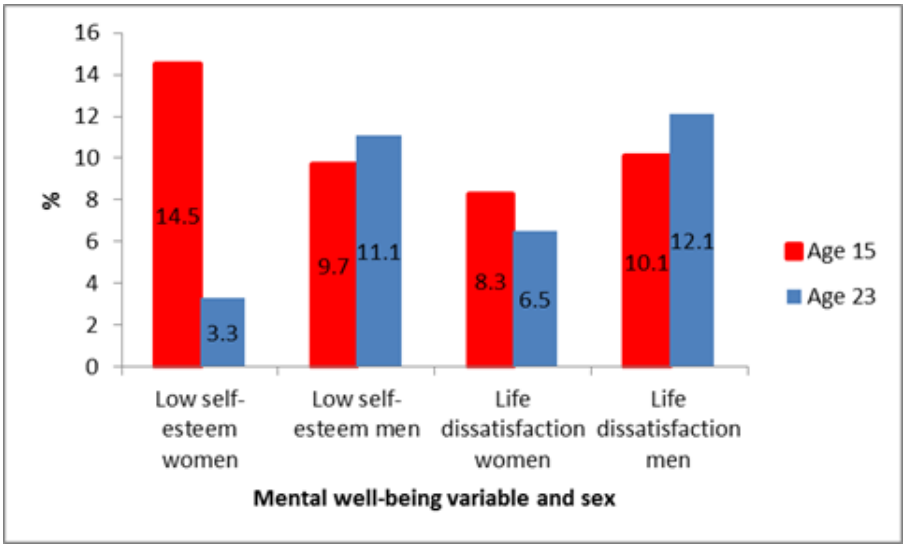


Figure 6. The proportion of females and males at ages 15 and 23 with low self-esteem and dissatisfied with life at age 23.

No gender difference was found for life satisfaction, at either time point, when measured with only two items from the SWLS (Table 6). However, when all items in SWLS were used (only at follow-up), females, aged 23, were more satisfied with life than males ($t(198) = 2.65$, $p = 0.009$) (Table 6). In the initial measurement (using only two items), a larger proportion of 15-year-old boys was dissatisfied with their life than girls, 10.1% vs. 8.3%, respectively. At the follow-up eight years later, a larger proportion of young men was still more dissatisfied with life than young women, 12.1% vs. 6.5% (Figure 6).

Results for the other mental well-being variables show that men had better scores than women, independent of age, for body image (F (1, 400) = 15.9, $p < 0.001$), anxiety (F (1, 400) = 24.2, $p < 0.001$), depression (F (1, 400) = 13.8, $p < 0.001$), and somatic complaints (F (1, 400) = 12.6, $p < 0.001$) (Table 6).

4.2 Physical activity, fitness and body image

4.2.1 Changes in physical measurements

Changes in aerobic fitness, PA, BMI and skinfold thickness from adolescence to young adulthood revealed that aerobic fitness and PA decreased while BMI increased, but no change was found in skinfold thickness among both genders from age 15 to age 23. The changes were significantly more negative for males than females. The gender differences in the decrease in aerobic fitness (Figure 7) was F (1, 110) = 5.5 for interaction, p = 0.021; for PA (Figure 8) the gender difference favoring females was F (1, 62) = 15.5 for interaction, $p < 0.001$; and for BMI (Figure 9) the gender difference in the increase was F (1, 199) = 17.6 for interaction, $p < 0.001$.

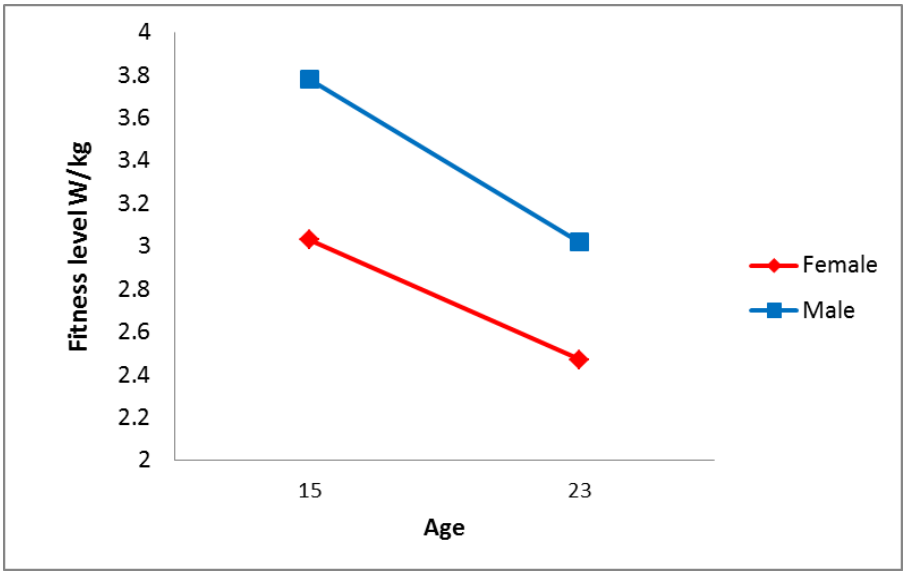


Figure 7. Gender differences in a decrease in aerobic fitness from age 15 and age 23 (males' fitness decreased more than females').

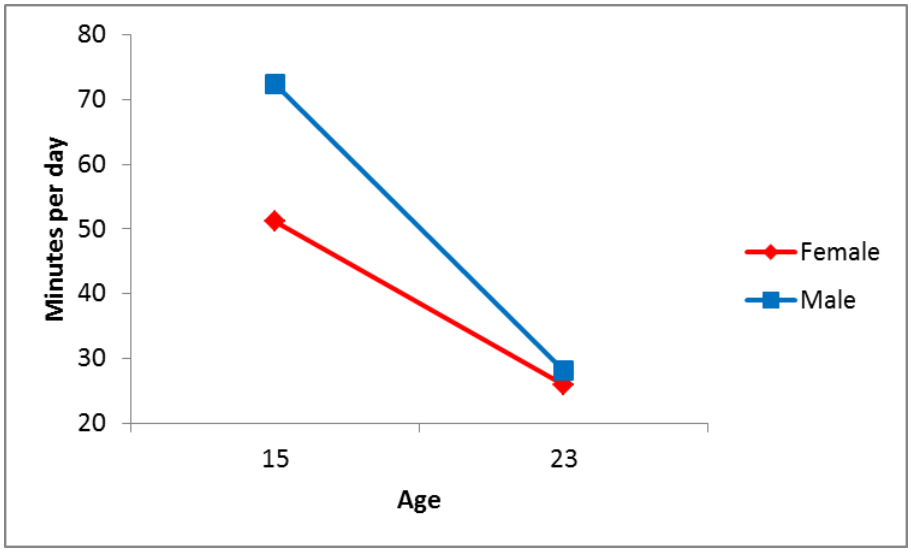


Figure 8. Gender differences in a drop in PA from age 15 to age 23 (males' PA decreased more than females').

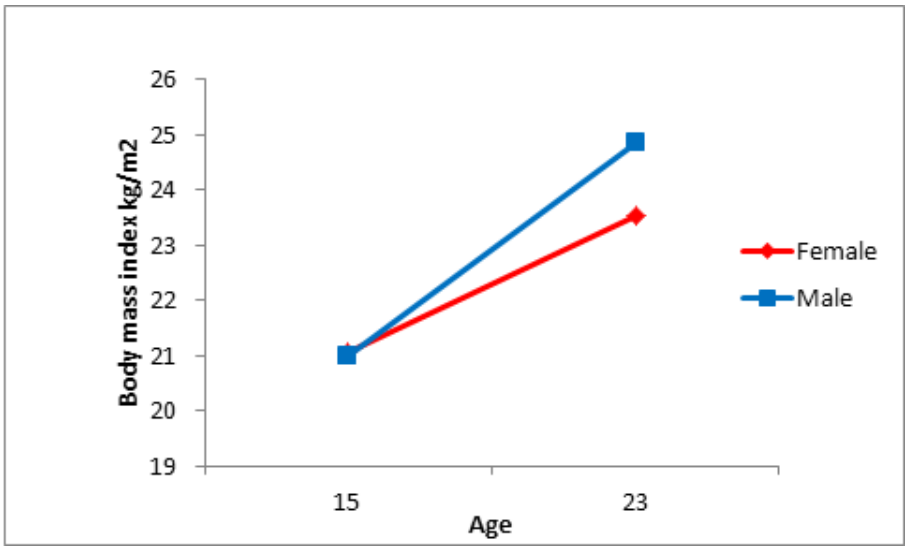


Figure 9. Gender differences in an increase in BMI from age 15 to age 23 (males' BMI increased more than females').

Aerobic fitness was significantly lower at follow-up for both females ($t(46) = 8.9$; $p < 0.001$) and males ($t(58) = 10.9$; $p < 0.001$), compared with baseline measures. There was a 2.8% drop per year on average in aerobic fitness among females and a 2.6% drop among males. Fewer female ($r_\tau = 0.36$; $p < 0.001$) and male ($r_\tau = 0.20$; $p < 0.05$) participants reported their fitness to be "good" or "excellent" at age 23, compared to their assessments at age 15. The

differences manifested especially in the percentage of those that rated their fitness as “excellent”; one-fifth of the female participant did so at age 15, whereas none of them made that claim at age 23. Similarly, at age 15, a third of the males self-reported their fitness as “excellent”, whereas only 6% did so at age 23 (Table 8).

The difference in PA between measurements was quite profound, as it fell by almost half amongst the females ($t(33) = 6.6$; $p < 0.001$) or by 6.2% per year on average and 60% for the males ($t(29) = 6.1$; $p < 0.001$) or 7.6% per year on average between baseline and follow-up (Table 8).

Table 8. Participants’ characteristics, for variables in the structural model and covariates.

Gender	**Females**		**Males**	
Age	**15**	**23**	**15**	**23**
Body image	14.1 (2.8)	14.8 (2.4)	15.4 (2.7)	15.4 (2.7)
Aerobic fitness[a]	3.1 (0.4)	2.4 (0.5)	3.8 (0.6)	3.0 (0.5)
Physical activity[b]	51.1 (19.7)	25.9 (15.3)	72.4 (29.4)	28.2 (16.8)
Self -reported fitness				
-Bad (%	33 (17.8)	18 (20.0)	19 (10.1)	13 (12.0)
-Okay (%)	34 (18.4)	45 (48.9)	36 (19.1)	45 (41.7)
-Good (%)	81 (43.8)	29 (31.5)	75 (39.7)	43 (39.8)
-Excellent (%)	37 (20.0)	0	59 (31.2)	7 (6.5)
BMI[c]	21.1 (2.9)	23.5 (3.7)	21.0 (3.0)	24.8 (4.0)
Sum of skinfold[d]	66.7 (22.8)	63.9 (25.9)	46.9 (25.5)	46.2 (21.2)

Data is presented as mean (SD) and count (%); [a]Measured in W/kg; [b]Presented as total minutes in moderate-vigorous activity; [c]BMI = Body mass index (kg/m^2); [d]Sum of four skinfolds measured (tricep, bicep, sub-scapular, suprailiac) measured in mm

4.2.2 Short-term association between PA, fitness and body image

Descriptive statistics of the variables in the structural equation model (Figure 10) testing the association between PA, fitness and body image, and the covariates tested in the model, are presented in table 8. Table 9 shows the correlations between items making up body image, fitness, and PA measures in the structural model, as well as the covariates tested in the model.

4.2.2.1 Factors related to body image in adolescents

When body image was regressed on PA and both fitness measures among 15-year-old females, only self-reported fitness was significantly associated with

body image (Figure 10). Once covariates (BMI, skinfold thickness, anxiety (a latent variable), and depression (a latent variable)) were added to the model, depression, in addition to self-reported fitness, emerged with a significant relationship with body image among females. Of the two, self-reported fitness had a stronger relation to body image ($\beta = 0.447$, $p < 0.001$), than depression ($\beta = -0.392$, $p < 0.001$). Put differently, by an increase of one standard deviation in self-reported fitness, their body image increased by 0.45 standard deviation. Self-reported fitness and depression explained 46.3% of the variance in body image of adolescent females.

When body image was regressed on PA and both fitness measures among 15-year-old males, aerobic fitness was the only variable having a significant relation to body image (Figure 10). After adding the covariates (BMI, skinfold thickness, anxiety, and depression) to the model, skinfold thickness, and aerobic fitness had a significant relation to the body image of males. Skinfold thickness had a stronger association with body image than aerobic fitness, skinfold thickness' standardized regression slope was -0.331 ($p < 0.001$) whereas for aerobic fitness it was 0.295 ($p = 0.004$). These two variables accounted for 25.8% of the variance in the body image of adolescent males.

4.2.2.2 Factors related to body image in young adults

When regressing body image on both fitness variables and PA, self-reported fitness stood out as the only significant variable among 23-year-old females (Figure 10). When adding covariates (BMI, skinfold thickness, depression, anxiety, and SES) to the model, BMI, depression and self-reported fitness were shown to have a significant relation to body image. BMI had the strongest association with body image ($\beta = -0.446$; $p < 0.001$). Self-reported fitness had the second strongest association with body image ($\beta = 0.368$; $p < 0.001$), and depression with β equal to -0.200 ($p = 0.027$). Together the three variables explain 48.9% of the variance in females' body image.

Among 23-year-old males, self-reported fitness had the only significant association with body image when body image was regressed on the primary measures (Figure 10). When covariates were added to the model the following four variables, skinfold thickness, BMI, depression and self-reported fitness, had a significant relation to males' body image. Skinfold thickness had the strongest relation to body image with a standardized regression slope equal to - 0.455 ($p = 0.002$). Depression had the second strongest relation,with a regression slope

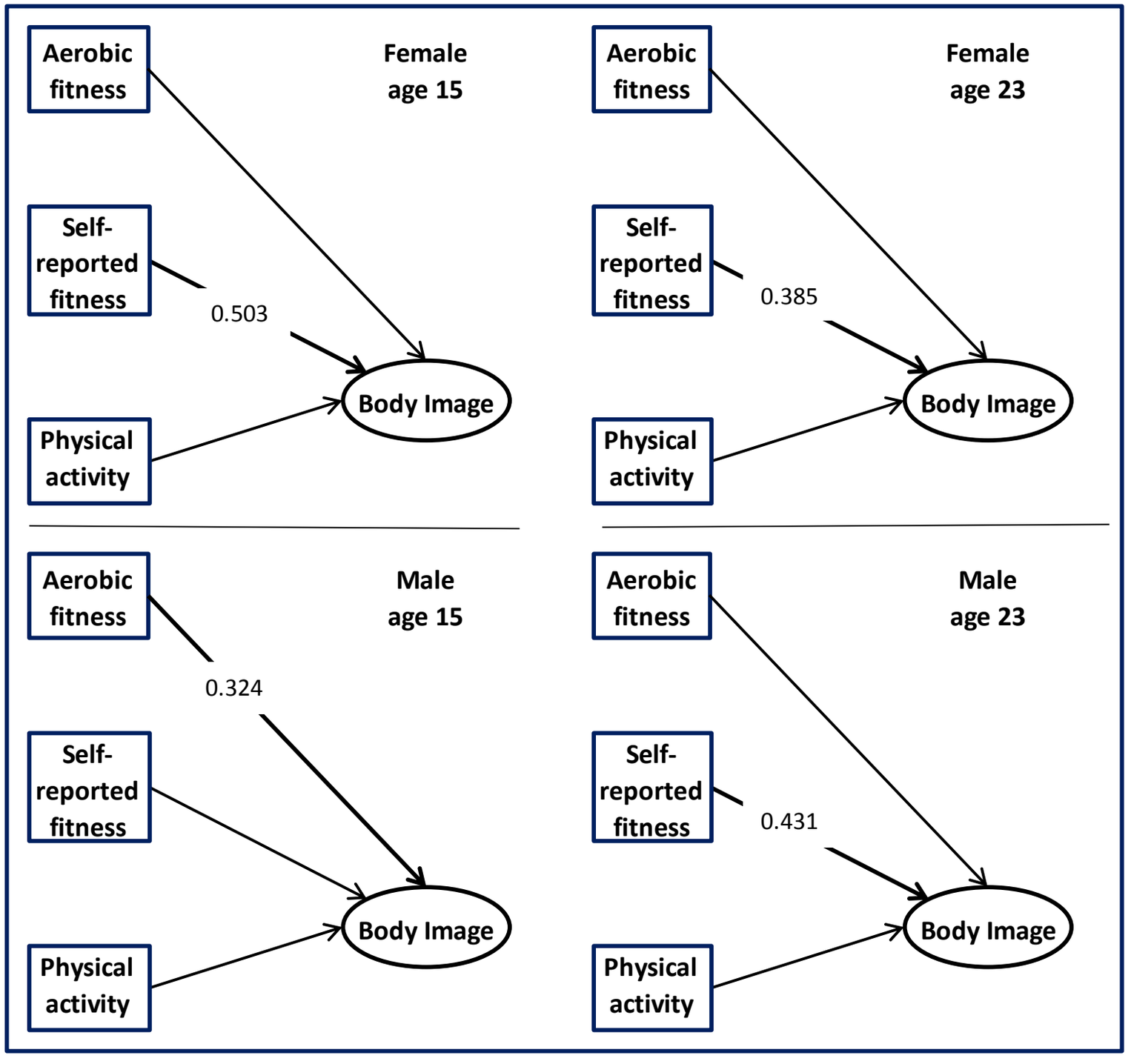


Figure 10. Structural models with statistically significant ($p < 0.05$) standardized estimates.

Table 9. Correlation of variables in the structural model and covariates at baseline (age 15) and follow-up (age 23).

Age 15	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Body image Item 1											
Body image Item 2	.407*										
Body image Item 3	.368*	.495*									
Body image Item 4	.365*	.343*	.558*								
Body image Item 5	.294*	.369*	.466*	.460*							
Aerobic fitness	.097	.306*	.430*	.282*	.329*						
S-R fitness	.167*	.253*	.328*	.237*	.454*	.433*					
Physical activity	.011	.066	.090	.126	.148	.473*	.246*				
BMI	-.040	-.104*	-.222*	-.078	.013	-.383*	-.156*	-.088			
Skinfold thickness	-.052	-.207*	-.343*	-.174*	-.104*	-.702*	-.324*	-.360*	.774*		
Anxiety	-.169*	-.230*	-.274*	-.128*	-.233*	-.261*	-.236*	.012	.026	.115*	
Depression	-.326*	-.371*	-.397*	-.208*	-.322*	-.335*	-.284*	-.056	.021	.113*	.644*
Age 23	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Body image Item 1											
Body image Item 2	.407*										
Body image Item 3	.524*	.492*									
Body image Item 4	.458*	.283*	.585*								
Body image Item 5	.457*	.267*	.511*	.506*							
Aerobic fitness	.111	.124	.333*	.238*	.352*						
S-R fitness	.233*	.107	.415*	.327*	.499*	.564*					
Physical activity	-.002	.117	.241*	.145	.137	.344*	.251*				
BMI	-.092	-.075	-.292*	-.178*	.049	-.314*	-.160*	-.104			
Skinfold thickness	-.159*	-.155*	-.391*	-.311*	-.172*	-.649*	-.363*	-.224*	.699*		
Anxiety	-.282*	-.231*	-.249*	-.153*	-.228*	-.113	-.154*	-.035	-.125	-.034	
Depression	-.243*	-.341*	-.288*	-.242*	-.258*	-.092	-.176*	-.234*	-.235*	-.014	.571*

*p < 0.05; S-R fitness = self-reported fitness; BMI = body mass index

equal to -0.371 ($p < 0.001$), then BMI, with a regression slope equal to 0.343 ($p = 0.016$) and, finally, self-reported fitness, with a standardized regression slope estimate equal to 0.322 ($p < 0.001$). Together the four variables accounted for 42.2% of the variance in males' body image at age 23.

4.2.3 Long-term association between fitness and body image

4.2.3.1 The cross-lagged structural equation model

A cross-lagged SEM (Figure 11) was used to analyze the long-term relation of aerobic fitness and self-reported fitness measured at age 15 to body image measured at age 23. Table 10 shows the inter-correlation of variables in the cross-lagged model. Means and standard deviations for measured variables at baseline and follow-up can be seen in table 11.

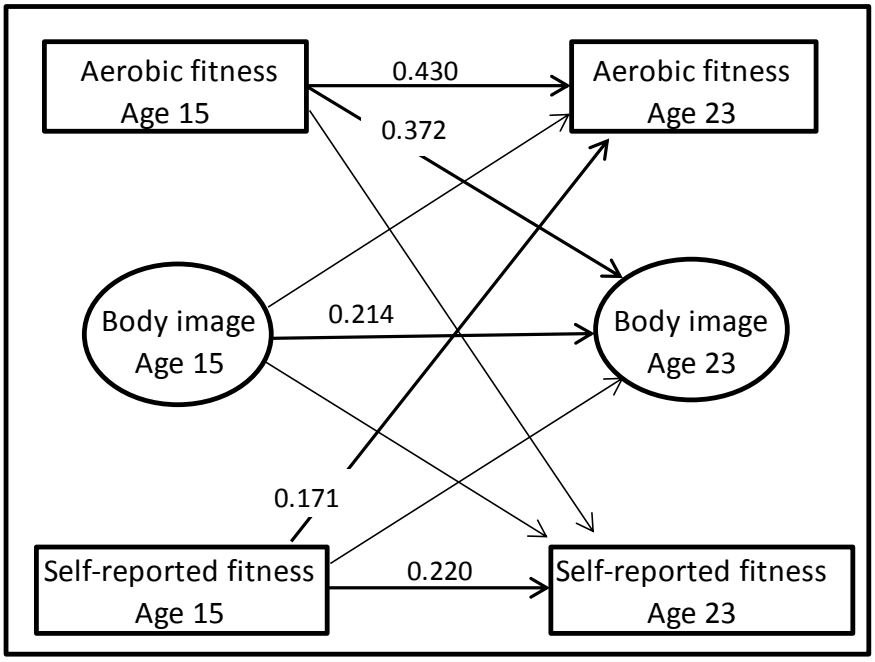


Figure 11. Cross-lagged structural equation model with significant standardized estimates.

Table 10. Correlations, for the variables in the structural model.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1) BI 15 v1													
2) BI 15 v2	0.404*												
3) BI 15 v3	0.370*	0.494*											
4) BI 15 v4	0.364*	0.342*	0.557*										
5) BI 15 v5	0.293*	0.370*	0.471*	0.454*									
6) BI 23 v1	0.352*	0.245*	0.325	0.291	0.249								
7) BI 23 v2	0.141	0.212*	0.212	0.101	0.158	0.383*							
8) BI 23 v3	0.233*	0.209*	0.247	0.161	0.142	0.509*	0.482*						
9) BI 23 v4	0.127	0.146	0.139	0.099	0.197	0.466*	0.302*	0.595*					
10) BI 23 v5	0.151	0.208	0.191	0.068	0.222	0.437*	0.289*	0.501*	0.508*				
11) AE fit 15	0.100	0.306*	0.430*	0.282*	0.330*	0.270*	0.360*	0.332*	0.256*	0.338*			
12) SR fit 15	0.165*	0.253*	0.329*	0.237*	0.451*	0.209*	0.246*	0.297*	0.268*	0.343*	0.443*		
13) AE fit 23	0.033	0.108	0.271*	0.078	0.148	0.096	0.100	0.364*	0.324*	0.315*	0.603*	0.380*	
14) SR fit 23	0.102	0.024	0.175*	0.067	0.226*	0.234*	0.110	0.417*	0.354*	0.479*	0.286*	0.347*	0.537*

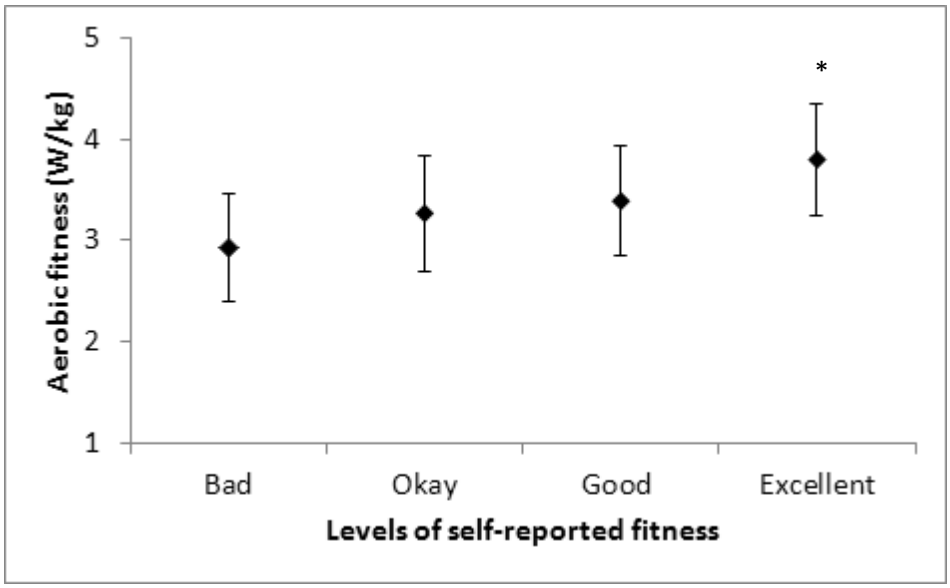
*p<0.05; BI 15 v1 = body image age 15 variable 1 etc.; BI 23 v1 = body image age 23 variable 1 etc.; AE fit 15 = aerobic fitness at age 15; SR fit 15 = self-reported fitness at age 15; AE fit 23 = aerobic fitness at age 23; SR fit = self-reported fitness at age 23.

Table 11. Descriptive statistics, means and SDs for variables at baseline and follow-up.

Variable	Age 15	Age 23	Score difference
Body image	14.9 (2.8)	15.1 (2.6)	p=0.379‡
Aerobic fitness – (W/kg)	3.5 (0.6)	2.8 (0.6)	p<0.001‡
Body mass index - (kg/m^2)	20.8 (2.9)	24.2 (3.9)	p<0.001‡
Physical activity (min per day)	60.5 (25.8)	27.2 (16.1)	p<0.001‡
Self-reported fitness % (N)			p<0.001*
Bad	13.9 (52)	15.5 (31)	
Okay	18.7 (70)	45.0 (90)	
Good	41.7(156)	36.0 (72)	
Excellent	25.6 (96)	3.5 (7)	

‡Paired t-Test; *Kendall's Tau-b; SD = standard deviation.

Aerobic fitness decreased during the study period, and fewer rated their fitness as "excellent" at follow-up than at baseline. Self-reported fitness was also categorized into four levels in accordance with the four response options. The 26% who reported their fitness as "excellent" at age 15, had higher aerobic fitness than the 42% individuals who reported their fitness as "good". The 19% that reported it as "okay", and the 14% that reported it as "bad", all $p < 0.05$ (Table 11). As seen in figure 12 self-reports of fitness and level of aerobic fitness were in agreement as mean aerobic fitness was on average 23% higher among those who reported it as "excellent" than those who reported it as "bad".



*Participants reporting their fitness as excellent had significantly higher aerobic fitness, $p < 0.05$).

Figure 12. Mean aerobic fitness score in each of the four groups of self-reported fitness at age 15.

The proportion of variance in body image at follow-up which the cross - lagged model accounted for was 22% (R^2 = 0.221). In the cross-lagged design, body image at age 15 did have a significant (p < 0.05) autoregressive effect on body image at age 23 but no cross-lagged effect on aerobic fitness or self-reported fitness at age 23 (Table 12). Aerobic fitness at age 15 had a significant (p < 0.001) autoregressive effect on aerobic fitness and a cross-lagged effect on body image at age 23 (Table 12); and self-reported fitness at age 15 had a significant autoregressive effect only on self-reported fitness at age 23 (p < 0.05) (Table 12). None of the covariates related to body image at age 23 (Table 12).

Table 12. Standardized coefficients (β) and standard errors (SE) for cross-lagged structural equation model, only significant covariate effect shown.

Paths	β	S.E.
Auto-regressive paths		
Body image age 15 → Body image age 23	0.214*	0.100
Aerobic fitness age 15 → Aerobic fitness 23	0.430*	0.108
Self-reported fitness age 15 → Self-reported fitness age 23	0.220*	0.085
Cross-lagged paths		
Body image age 15 → Aerobic fitness age 23	-0.094	0.078
Body image age 15 → Self-reported fitness age 23	-0.062	0.090
Aerobic fitness age 15 → Body image age 23	0.372*	0.128
Aerobic fitness age 15 → Self-reported fitness age 23	0.035	0.127
Self-reported fitness age 15 → Body image age 23	0.185	0.095
Self-reported fitness age 15 → Aerobic fitness age 23	0.171*	0.077
Covariate effect		
Gender → Aerobic fitness age 15	0.491*	0.046
Gender → Body image age 15	0.165*	0.063
BMI age 15 → Body image age 15	-0.125*	0.055
BMI age 15 → Aerobic fitness age 15	-0.311*	0.044
BMI age 15 →Self-reported fitness age 15	-0.068*	0.078
PA age 15 → Self-reported fitness age 23	0.345*	0.105
PA age 15 →Aerobic fitness age 23	0.187*	0.090
PA age 15 → Body image age 15	0.265*	0.078
PA age 15 → Aerobic fitness age 15	0.324*	0.055
PA age 15 → Self-reported fitness age 15	0.403*	0.069

*p < 0.05; BMI = body mass index; PA = physical activity

4.3 Additional results

4.3.1 Relationship between self-esteem and fitness—mediating role of body image

4.3.1.1 Adolescence

In adolescent females and males, no direct association was found between aerobic fitness and self-esteem. However, an indirect relation was found between the two variables via mediation through body image, and this effect was independent of gender. The regression path between self-esteem and body image in adolescent females was significant ($\beta = 0.921$; $p < 0.001$) as was the reggression path between body image between and fitness ($\beta = 0.414$; $p < 0.001$) (Figure 13). The mediation model explained 17.1% of the variance in body image and 79.7% of the variance in self-esteem. The test of the indirect relation between self-esteem and fitness revealed a significant relation ($\beta = 0.381$; $p = 0.001$), and the 95% bootstrap confidence interval around the indirect effect did not contain a zero (0.169 - 0.594).

The regression path between self-esteem and body image in adolescent males was significant ($\beta = 0.67$; $p < 0.001$) and between body image and fitness ($\beta = 0.38$; $p = 0.001$) (Figure 13). The mediation model explained 14.8% of the variance in body image and 44.1% of the variance in self-esteem. The test of indirect relation between self-esteem and fitness revealed a significant relation ($\beta = 0.258$; $p < 0.05$) and the 95% bootstrap confidence interval around the indirect effect did not contain a zero (0.064 - 0.452).

4.3.1.2 Young adulthood

Among young adult females, no direct association between aerobic fitness and self-esteem was found. The path between self-esteem and body image was significant ($\beta = 0.823$; $p < 0.05$), as well as the path between body image and fitness ($\beta = 0.457$; $p < 0.001$) (Figure 13). The mediation model for females in their young adulthood explained 20.9% of the variance of body image and 57.1% of the variance in self-esteem. The test of indirect relation between self-esteem and fitness revealed a significant relation ($\beta = 0.376$; $p < 0.001$) and the 95% bootstrap confidence interval around the indirect effect did not contain a zero (0.169 - 0.583).

Among young adult males, a direct association between aerobic fitness and self-esteem was found. ($\beta = -0.190$; $p < 0.05$), The path between self-esteem and body image was significant ($\beta = 0.622$; $p < 0.001$), as well as the path between body image and fitness ($\beta = 0.278$; $p < 0.05$) (Figure 13). The mediation model for males in young adulthood explained 7.7% of the variance of body image and 35.8% of the variance in self-esteem. The test of indirect

relation between self-esteem and fitness revealed a significant relation (β = 0.173; $p < 0.05$) and the 95% bootstrap confidence interval around the indirect effect did not contain a zero (0.032 - 0.314).

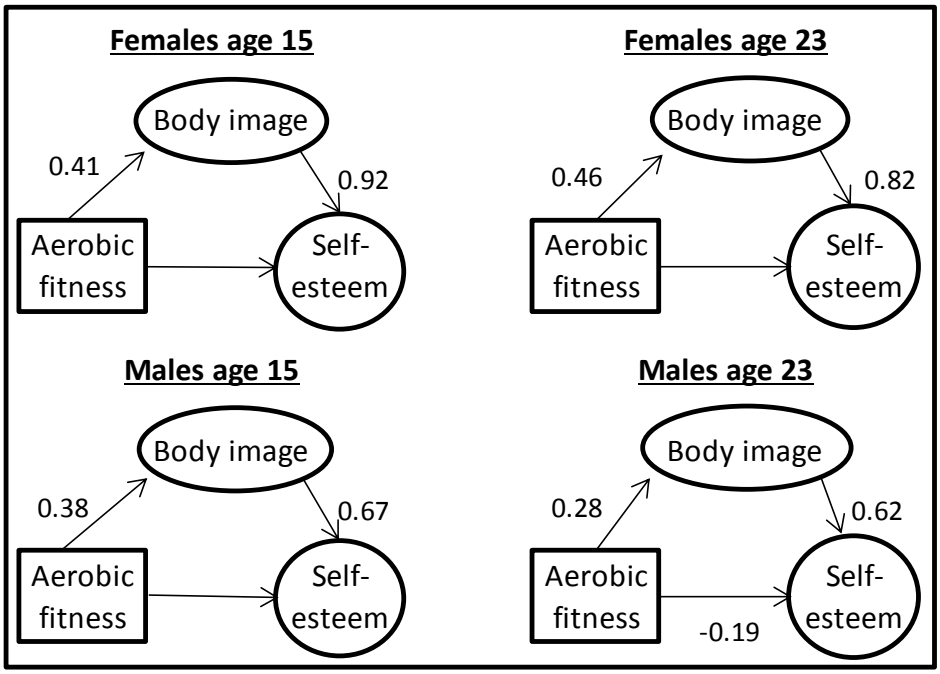


Figure 13. Significant standardized estimates for the mediation models for both genders at both time points.

5 Discussion

The main aims of this doctoral study were to analyze changes in mental well-being from adolescence to young adulthood, and to study how mental well-being relates to PA and fitness. Changes found in mental well-being from age 15 to age 23 revealed that self-esteem increased, life satisfaction decreased, anxiety decreased and somatic complaints became fewer, but body image and depression did not change in participants. Changes found in physical measurements showed a decrease in aerobic fitness and PA, an increase in BMI, but no change was found in participants' skinfold thickness from age 15 to age 23. Regarding self-reports on aerobic fitness, a lower percentage of participants reported their fitness as "good" or "excellent" at age 23 than did so at age 15. Mental well-being did not relate to PA, but short-term and long-term association was found between fitness and body image.

5.1 Gender differences in mental well-being

In regard to cross-sectional findings, females were more satisfied with life than males at follow-up (measured with SWLS), but males had higher scores than females on body image, anxiety, depression, and somatic complaints, independent of age. Adolescent males also had better self-esteem than adolescent females, but no gender difference was found for self-esteem in participants in their young adulthood. Conversely, the only gender difference found in changes in mental well-being was in self-esteem, where females' self-esteem increased more than for the males from baseline to follow-up. It was interesting to discover that the cross-sectional gender differences found in self-esteem at the age of 15 had disappeared at 23 years of age. The finding that boys had better self-esteem than girls during adolescence is, however, consistent with the literature (Derdikman-Eiron et al., 2011; Kling et al., 1999).

It is well documented that women's psychological distress increases much more than men's during adolescence (Aslund et al., 2010; Derdikman-Eiron et al., 2011; Frost & McKelvie, 2004; Kling et al., 1999). Numerous demographic, biological, social and psychological explanations for these gender differences have been proffered (Afifi, 2007). However, the lack of gender differences in self-esteem at age 23 is inconsistent with earlier findings (Robins, Trzesniewski, Tracy, Gosling, & Potter, 2002), where men have been found to have better self-esteem than women. The finding that women at age 23 were more

satisfied with life than men is also contrary to previous results (Diener & Diener, 1995), yet fits with the increased self-esteem of women seen from age 15 to 23 in the current study.

Even though women's self-esteem caught up with men's, and the former were more satisfied with life at age 23, they had significantly worse scores on body image, depression, and anxiety, and more somatic complaints than men, which is in line with previous reports (Holsen, Jones, & Birkeland, 2012). Since a larger proportion of females than males in this study were attending secondary school or higher education at the age of 23, it could be speculated that the schoolwork put extra strain on women, affecting their depression and anxiety while boosting their self-esteem. It is possible that the enhancement of women's global self-esteem through their education may have been affected by an increase in their academic self-esteem (a domain-specific self-esteem at the second level of the hierarchy of the self-esteem), which then positively influenced their global self-esteem (the top level of the hierarchical construct of the self-esteem). Or perhaps the measures of self-esteem, anxiety or depression are not as good for assessing the mental well-being of men compared to the mental well-being of women. It has been reported that many mental well-being scales were developed with samples of women only and might therefore not be as representative for males (Huang, 2010). Maybe the measure of life satisfaction gives more accurate information on males' mental well-being, as they were found to be less satisfied with their life than females.

5.2 Gender differences in physical activity and fitness

As expected, due to biological factors and findings from previous studies (Johannsson, Arngrimsson, Thorsdottir, & Sveinsson, 2006), males were more physically active, had better aerobic fitness, body mass index and skinfold thickness than females, independent of age. Moreover, a larger proportion of males than females reported their fitness to be "excellent" at both time points. Gender differences in the change in physical well-being show that males' PA, aerobic fitness, and BMI worsened more than the females. The noted gender differences in the decline of PA are in line with the study of Telama and Yang (2000) on 12-18 year old adolescents and Caspersen, Pereira, and Curran's (2000) study on 12-29 year old individuals. The striking decline found in PA from adolescence to young adulthood in this doctoral study mirrors the results found in other studies measuring PA objectively (Corder et al., 2015). The systematic review of Dumith, Gigante, Domingues, and Kohl (2011) revealed a decline in PA (measured both objectively and by self-report) during the adolescent years, with more drop in PA for 13- to 16-year-old boys than girls of the same age. These results are in line with our results, where the drop in PA

from baseline to follow-up among males was more than the drop among females. The decline found in participants' aerobic fitness in the current study is most likely due to the decline in PA over the study period. The reduction in aerobic fitness is also in agreement with previous findings (Tomkinson & Olds, 2007). The decrease in participants' aerobic fitness paralleled their perception of fitness, but the percentage of participants evaluating their fitness subjectively as being excellent fell dramatically between the ages of 15 and 23. It can be speculated that increased use of passive transport was one of the reasons why PA and fitness dropped from age 15 to age 23, for at the age of 17 Icelandic youth may get a driver's license. It has been well known that males are more fascinated with cars than females, which could explain the gender differences of the drop in PA and fitness. They are more eager than females to get their drivers licenses and access to more passive transport.

The decreases in physical health and endurance found in the current study may partially explain why males' self-esteem increased less than females' from baseline to follow-up. Even though the body image and self-esteem of males did not change from age 15 to age 23, and were, in fact, better than the females', it is possible that the greater life dissatisfaction measured among males not only demonstrates an accurate measure of their mental well-being but also mirrors the deterioration of physical health occurring in males.

5.3 Mental well-being, physical activity and fitness

5.3.1 Short-term association between PA, fitness and body image

It was interesting to find that PA was not significantly associated with the body image of males or females in either age group and that aerobic fitness was only associated with body image among adolescent males, as previous studies have found an association between exercise and more positive body image across all ages (Hausenblas & Fallon, 2006). Conversely, factors associated cross-sectionally with body image consisted of skinfold thickness, BMI, depression and self-reported fitness.

There is scant research on the association between PA and body image but given the impact that PA has been found to have on individuals' health and well-being (Penedo & Dahn, 2005), it was noteworthy to find that it did not have any affect on participants' body image. There may be a few explanations for this. First, some studies revealing a positive effect of PA on mental well-being have relied on self-reports, but in the current study, we used accelerometers that provide a much more accurate and detailed measure of PA than a self-report. Second, our finding could be attributed to a lack of power, as only 92 (of the 195) men and 81 women (of the 190) at the age of

15, and 79 men (of the 109) and 69 women (of the 92) at the age of 23, fulfilled the criterion of carrying the accelerometer on their hips for a one whole week.

It was remarkable to find that aerobic fitness only had a significant association with body image among adolescent males, as previous research findings (Grao-Cruces, Fernandez-Martinez, & Nuviala, 2014; Kantomaa, Tammelin, Ebeling, Stamatakis, & Taanila, 2015; Ortega et al., 2008) have found a positive effect of fitness on overall health. Since skinfold thickness, and aerobic fitness were the only two variables significantly associated with body image among 15-year-old males, it could be speculated that males' ability and performance in sports are important for their body image, especially as being physically active can boost their muscular, masculine cultural body ideal. Skinfold thickness in males in their young adulthood had the strongest association with their body image, just like during adolescence. However, depression, BMI, and self-reported fitness related to their body image in young adulthood, whereas aerobic fitness did not. The increased use of social network sites, where users present themselves to others through pictures and text and then read comments from others on their self-presentation (Espinoza & Juvonen, 2011; Pempek, Yermolayeva, & Calvert, 2009), is perhaps affecting the importance of fitness for well-being. Reading comments on their looks online may for instance increase the importance of the subjective view of fitness and body composition, compared to the actual aerobic fitness level. One could also speculate that this could also affect females' perception of their body in their young adulthood. Very few studies have examined the effect of social network use on body image, and the few that have been conducted have focused on adolescents. In the study of de Vries, Peter, de Graaf, and Nikken (2016), the use of social network sites predicted body image dissatisfaction in both females and males aged 11-18.

In the current study, female participants' body image was related most strongly to how they perceived their fitness, followed by depression, but no association was found with aerobic fitness, PA or body composition. How adolescent females feel about their bodies seems to be more important than their actual body size and shape. In young adulthood, body shape and size seem to be important to females as well the subjective factors. BMI, which had the strongest association with body image, was negatively related to body image, while self-reported fitness and depression were positively and negatively associated with body image (respectively). It was noteworthy to find that depression had a significant relation to females' body image at both time points. This relation perhaps hints that females being treated for mood disorders (which females are most commonly treated for (Kessler, 2003))

should also be treated for body image dissatisfaction. The variance in body image explained by significant variable associations in the model increased among males from 25.8% at age 15 to 42.2% eight years later. For females, the increase was less. The explained variance increased from 46.3% at age 15 to 48.9% at age 23.

Overall, these findings indicate that diverse motives and influences shape the body image of individuals, and that specific motives differ not only across men and women but also between adolescence and young adulthood. The factor loadings of the indicators measuring body image also changed from adolescence to young adulhtood. This might support the idea that different approaches are needed to improve body image. It is imperative to bear these gender differences in mind when trying to formulate a strategy for improving individuals' body image, which in itself can be construed as a vital public health initiative. These results indicate that different intervention programs may be needed to boost body image across gender at different time points in an individual's life. In recent years, researchers have mainly focused on body image dissatisfaction in women (Martin Ginis et al., 2014; Stice & Whitenton, 2002), but as Sladek, Engeln, and Miller (2014) have pointed out, the issue has largely been ignored with regard to men. It has probably been ignored due to study results of gender differences in body image, where males are most often found to have better body image than females (Frost & McKelvie, 2004).

5.3.2 Long-term association between fitness and body image

When focusing on the longitudinal measures, a long-term association between fitness and body image was found. Aerobic fitness was a stronger predictor of body image than self-reported fitness, and notably, aerobic fitness constituted a stronger predictor of body image at follow-up than body image measured at baseline. This finding is especially interesting because mean aerobic fitness level decreased during the eight-year period, but mean body image score did not change during the same period. Even though it is not clear at what point body image becomes reasonably stable (Smolak, 2004), the consistency in body image over the eight years, despite a decrease in aerobic fitness, could be explained by participants' maturity, meaning they worry less about their looks with increased maturity. Our results mirror those of others which have indicated that the importance of body appearance seems to decrease with increasing age (Frisen, Lunde, & Berg, 2015; Tiggemann, 2004).

Contrary to aerobic fitness, self-reported fitness was not associated with body image. One can speculate that self-reported fitness might be a proxy for body composition instead of being a measure of fitness and, similar to BMI,

does not therefore have a significant effect on body image. Supporting this speculation is the evidence that adolescents frequently relate fitness to appearance and to “looking good” (Haugen et al., 2013). One has to keep in mind that the self-reported measure of fitness was only one question in the questionnaire, and perhaps a more robust variable assessing self-reported fitness would have resulted in a significant association. However, those reporting their fitness as “bad” had the worst aerobic fitness, and those reporting their fitness as “excellent” had the best aerobic fitness, supporting the content validity of the item.

These overall results indicate that aerobic fitness in adolescence, especially when assessed objectively, marks an important, influential factor for a healthier body image in young adulthood. Indeed, long-term analyses indicate that body image dissatisfaction in early and middle adolescence predicts later signs of mental distress, i.e., depressive symptoms and lower global self-esteem (Holsen, Kraft, & Roysamb, 2001; Johnson & Wardle, 2005; Stice & Bearman, 2001). Persons with a more favorable body image are obviously more likely to take better care of their bodies and to be more comfortable about exercising in public. Body image may therefore be seen as a key factor for the development of both mental and physical health (Darby et al., 2007; Stice, 2002; Wiederman & Pryor, 2000). Although the long-term cross-lagged model explained only a little over 20% of the variance in body image at age 23, this finding can be construed as indicating that an individual can sustain and nurture his or her body image, long term, through maintaining good aerobic fitness levels. In addition, persons with a low fitness level should be able to increase their fitness with relatively little effort and low cost, which again would have a positive effect on body image that would hopefully help to increase mental well-being.

Exercise among women has been shown to improve their body satisfaction and affect, independent of their previous level of body dissatisfaction (LePage & Crowther, 2010). DiLorenzo et al. (1999) found in their study of individuals between the ages of 18 and 39 that psychological benefits gained from a 12-week fitness building program were maintained at the one-year follow-up, independent of increased participation in PA. Importantly, the result of three meta-analyses (Campbell & Hausenblas, 2009; Hausenblas & Fallon, 2006; Reel et al., 2007), assessing the effects of different types of exercise intervention on body image, have indicated that exercise-training programs are effective for improving body image. However, the majority of previous studies have been based on mostly female samples.

Unsurprisingly, cross-sectional studies among adolescents have found associations between BMI and body image dissatisfaction (Banitt et al., 2008; Presnell, Bearman, & Stice, 2004), and between obesity and body image dissatisfaction (Schwartz & Brownell, 2004). Being unhappy with body size and shape is a common concern for adolescents. Congruently, cross-sectional associations were found between BMI and body image at age 15 in the current study, whereas no long-term associations were found between these two variables (i.e., BMI in adolescence had no relation with body image in young adulthood). In light of these findings, it seems that BMI, at least within the normal range at one time point in life, does not affect body image later in life. It can be speculated that if more extreme BMI scores (high or low BMI) would have been specifically investigated in this study, an association between BMI and body image could have emerged, as u-shaped associations have been found between BMI and depression (de Wit, van Straten, van Herten, Penninx, & Cuijpers, 2009). It is, however, important to keep in mind what Etnier, Nowell, Landers, and Sibley (2006) have pointed out: in order to observe cognitive benefits of PA, changes in aerobic fitness have to take place. Furthermore, the PA needs to reach a certain intensity for it to affect aerobic fitness and then have cognitive benefits.

5.4 The association between self-esteem and fitness

Body image and self-esteem have been found to be highly associated in adolescents (independent of gender) (van den Berg et al., 2010). The physical development in adolescence is commonly accompanied by the emergence of body dissatisfaction, as well as the decline in self-esteem, particularly among females. From a mental health perspective, it is important to study what factors sustain a positive body image in individuals, given the importance of body image for general health and well-being, especially for global self-esteem.

It is well-established, as mentioned above, that PA and good physical fitness positively affect mental well-being. However, how these two influence each other is not quite clear. In this doctoral study, an association was found between aerobic fitness and self-esteem through body image. Body image was a full mediator of the association between body image and fitness for both genders in adolescence and among females in young adulthood. Conversely, body image was a partial mediator between aerobic fitness and self-esteem in males in young adulthood. Ortega et al. (2008) have indicated two possible underlying mechanisms explaining the relationship between physical fitness and body image: a) the decrease in fat mass and increase in lean mass, which are usually associated with increased physical fitness, are quite visible to people (enhancing their body image); and b) improvements in physical fitness could have a direct effect on neurochemicals in

the brain like endorphins and serotonin that serve to uplift mood, which, in turn, leads to a more positive view of one's body. These two explanations seem to explain a short-term or cross-sectional influence better than the long-term influence of physical fitness on body image. A better longitudinal explanation could be that physical fitness influences body image, which then influences self-esteem. Higher self-esteem then encourages healthy exercise routines. Global self-esteem is, as previously mentioned, derived from individuals' self-evaluation in different domains (e.g., physical self-esteem and academic self-esteem) (Rosenberg et al., 1995). Good fitness can hopefully sustain healthy exercise habits and thereby improve body image, which then results in increased overall mental well-being.

5.5 Strength and limitations

The main strength of the current thesis is the longitudinal design of the study, which allowed for comparison between the same individuals at two time points in their life, at age 15 and again at age 23. Longitudinal studies are particularly useful when studying development. Such studies are, however, time-consuming and often quite expensive, and participant dropout from the study can be problematic. Moreover, we have objective measures of aerobic fitness and PA, which have most often been measured with self-reports in other studies. Furthermore, we also included a subjective measure of fitness, so we were able to compare the effect of an objective and a subjective measure of fitness on body image. To our knowledge, no study has examined the long-term effect of fitness (measured in two different ways) on body image. Due to the considerably small sample size, a separate analysis by gender was not conducted when long-term associations between fitness and body image were analyzed. This could have limited interpretation of the results. The low number of participants with valid PA measures also constitutes a weakness that may limit the power of the study. Another weakness of the study is that we did not have a measure of SES for baseline measures. However, SES measured at follow-up did not have any association with body image at follow-up.

The questionnaire has several limitations. Also measuring life satisfaction at baseline with the SWLS would have improved the study. Some of the measurement tools are shortened versions of widely used questionnaires. Although these shorter versions demonstrate good validity, they may involve some reduction in sensitivity. By using SEM, however, we were able to account for the measurement error of latent variables in the analyses. SEM has the advantage of allowing for simultaneously running a confirmatory factor analysis for the latent variables as well as running a regression analysis to test for the association

between latent and observed variables. However, one of the three goodness-of-fit indices used to estimate the fit of measured SEM models did not reach accepteble fit for all of the models. This may have limited interpretation of the results. The measurement invariance test for anxiety indicates that participants at age 15 understood the construct differently than they did at age 23. The measurement invariance test for depression indicates males understood the construct differently across age.

The dropout rate is also worth considering. No statistical differences were found on any of the mental well-being variables measured at baseline between dropouts and non-dropouts. The only difference in physical measurements found at baseline between dropouts and non-dropouts was in BMI. The dropouts had significantly higher BMI than those measured again at follow-up indicating that overweight participants did not return to follow-up.

6 Conclusion

The findings suggest that the gender differences in self-esteem found in adolescents are not as long lasting as previously believed. Furthermore, the findings add to our knowledge of the development of self-esteem and the other mental well-being variables from adolescence into young adulthood. Other findings in the dissertation indicate the need for males and females to be approached differently when it comes to efforts to improve their body image in adolescence and young adulthood. Female participants' body image was related to how they perceived their fitness (both in adolescence and young adulthood). Therefore, enhancement of their self-perceived fitness may seem a viable approach to obtain a better body image satisfaction. On the other hand, adolescent male participants' body image was most affected by their aerobic fitness. Hence, for them enhancing, and maintaining, their aerobic physical capability may prove effective for increasing body satisfaction. In young adulthood male participants' body image was influenced by both body composition and how they perceived their fitness. Therefore, one could speculate that improving body composition would also enhance their fitness perception and thereby their satisfaction with their body image. The findings also support the presence of a positive effect of aerobic fitness in adolescence on body image eight years later. The findings also add to the current literature by examining the longitudinal effect of fitness on body image. They show that better aerobic fitness in adolescence predicts a positive body image in young adulthood, independent of gender, SES, PA and body composition. In light of these finding, it may be important to encourage adolescents to stay active, so their aerobic fitness does not decrease too dramatically during these critical formative years in their lives. Good aerobic fitness is likely to affect individuals' overall well-being when impacting body image. This will in turn benefit young people during their transition from adolescence to young adulthood.

It is well established in the literature that good fitness and physical activity have positively affect mental well-being, and it is also well known that body image and self-esteem are highly associated. The results from the mediation model, where body image was found to mediate the relation of aerobic fitness to self-esteem, indicate how aerobic fitness affects self-esteem, i.e., through body image. The findings of this doctoral study advance the knowledge of the association between aerobic fitness, self-esteem and body image from

adolescence to young adulthood. Indeed, Ortega et al. (2008) have pointed out in a review of the literature that studies investigating the relationship between physical fitness and mental health in young people are lacking. This dissertation is mainly based on three papers covering a "new" and important period in life. Some researchers have started calling this period *emerging adulthood.* This stage of longer education, delayed marriage, and parenthood, when initial romantic relationships start forming, afford more opportunities to try out different ways of living. More options for work and love lead to increased emotional stress (Arnett, 2014). This calls for attention to what can improve young adults' mental and physical well-being. This doctoral thesis contributes to the understanding of how young individuls' mental and physical condition change during their transition from adolescence to young adulthood, and how these two conditions are associated. The key findings were that females' mental well-being showed more positive changes than the males', with their self-esteem increasing during the eight-year study period. Women were also more satisfied with life than males at follow-up. Males' BMI, PA and fitness worsened more than females' did during the study period, and a long-term association was found between fitness and body image. Study results also indicate that different approaches might be needed across gender and age to improve body image.

7 Future perspectives

According to WHO (1978), a broad view of health takes into account individuals' physical, psychological and social well-being. This dissertation directed the focus to the psychological and physical aspect of health. It would therefore be interesting in further studies to explore which social factors have the strongest impact on young persons' health. This could be done by including information about any environmental changes that have occurred in participants' lives. Since the transition from adolescence to young adulthood involves widespread changes in their educational and social environment and alterations affecting life-long physical and psychosocial well-being and lifestyle behaviors, further prospective studies are needed to understand the mechanisms underlying the development of the mental well-being factors for both genders during this transition period. Future studies should also focus on the causes of the discrepancies in the changes of mental well-being scores from adolescence to young adulthood, i.e., the improvement, in self-esteem but not other variables for women and more life dissatisfaction among men than women. It is also important to study the changing media landscape with the widespread use of social networks (e.g., Facebook, Instagram, Snapchat, Twitter), and to find out how cyberspace influences body image both in adolescents and young adults.

Regarding the results of this dissertation, it would be very interesting to go into more detailed analysis of why young males are more dissatisfied with life than young females, and it would be especially interesting to find out if life satisfaction is a stronger measure of mental well-being in males than the measure of self-esteem and the other mental well-being variables used in this dissertation. It would also be very curious to compare the effects of variables other than fitness that can be measured both subjectively and objectively, such as PA and BMI, on the mental well-being variables. The results from such comparisons could indicate that both objective and subjective measures of variables are needed to explain the variance in mental well-being. The results from such comparison could in turn support further speculation on different methods to boost mental well-being. As mentioned earlier in the dissertation, Hakkinen et al. (2010) have highlighted the lack of evidence on the association between physical fitness and health-related quality of life (a person's perceived physical and mental well-being) in young adults. But as Asci (2009)

pointed out, little is known on whether during adolescence exercise benefits females' and males' mental well-being differently.

As body image was found to mediate the association between fitness and self-esteem, it would also be very interesting to study what factors mediate or moderate the association between fitness and body image, both cross-sectionally and longitudinally. The theoretical influence of fitness on body image that results in higher self-esteem could as well be an appropriate area for future research. The results of this study indicated that both PA and aerobic fitness decreased more among males than females from age 15 to age 23; that females' self-esteem increased more than the males' self-esteem during the period, and that aerobic fitness is an important, influential factor for self-esteem through body image. In the future, it would be interesting to study whether, and how, life satisfaction influences self-esteem, especially in the light of the results found in this dissertation that males at age 23 were less satisfied with life than females the same age. The most interesting study would be to call these same participants in a third time for measurements and analyze what changes have occurred. This "new" period in young people's lives, where a person is not an adolescent anymore, but still not an adult, is an extremely interesting new research era.

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Papers

Paper 1:

Gestsdottir, S., Arnarsson, A., Magnusson, K., Arngrimsson, S. A., Sveinsson, T., and Johannsson, E. (2015). **Gender differences in development of mental well-being from adolescence to young adulthood: An eight-year follow-up study**. *Scandinavian Journal of Public Health, 43*(3), 269-275.

Paper 2:

Gestsdottir, S., Svansdottir, E., Sigurdsson, H., Ommundsen, Y., Arnarsson, A., Sveinsson, T., Arngrimsson, S., and Johannsson, E. **The association between physical activity, fitness and body image in adolescence and young adulthood – An eight-year follow-up study.** Submitted January 2016.

Paper 3:

Gestsdottir, S., Svansdottir, E., Ommundsen, Y., Arnarsson, A., Arngrimsson, S., Sveinsson, T., and Johannsson, E. (2015). **Do aerobic fitness and self-reported fitness in adolescence differently predict body image in young adulthood? An eight-year follow-up study**. *Mental Health & Physical Activity*, doi:10.1016/ j.mhpa.2015.12.001.

Paper 1

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ORIGINAL ARTICLE

Gender differences in development of mental well-being from adolescence to young adulthood: An eight-year follow-up study

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Abstract

Background: The transition from adolescence to young adulthood is marked by many changes. Mental well-being plays an important role in how individuals deal with these changes and how they develop their lifestyle. The goal of this study was to examine gender differences in the long-term development of self-esteem and other mental well-being variables from the age of 15 to the age of 23. *Methods:* A baseline measurement was performed in a nationwide sample of 385 Icelandic adolescents aged 15, and a follow-up measurement was conducted eight years later, when participants had reached the age of 23. Standardized questionnaires were used to measure self-reports of self-esteem, life satisfaction, body image, anxiety, depression and somatic complaints. *Results:* Women improved their self-esteem significantly more than men from the age of 15 to 23 (p=0.004). Women were more satisfied with their life than men at the age of 23 (p=0.009). Men had a better body image, less anxiety, less depression and fewer somatic complaints than women, independent of age. Across gender, anxiety declined and somatic complaints became fewer (p<0.05). ***Conclusions:*** **These findings suggest that gender differences in mental well-being factors, favouring men, found in adolescents, are not as long-lasting as previously thought. Women improve their mental well-being from adolescence to young adulthood while men's mental well-being does not change.**

Key Words: *Mental well-being, self-esteem, life satisfaction, adolescence, young adulthood*

Background

The transition from adolescence to young adulthood is a time of rapid physical, social and cognitive changes, as individuals start establishing their own lifestyle patterns and form health-related behaviours, which tend to be stable throughout life [1,2]. Many of them also face transition from secondary school to university, involving changes in their educational environment, as well as adaptations that may affect their physical and psychosocial well-being and choices between lifestyle behaviours [1,3].

Mental well-being is related to a wide range of disciplines, which results in a slightly different understanding of the concept [4,5]. Generally, measurement of mental well-being includes evaluation of self-esteem, life satisfaction, happiness, optimism, mastery and feeling in control, having a purpose in life, and a sense of belonging and support [6]. These measurements reflect the hedonic and eudaimonic perspectives that have become accepted as encompassing the meaning of mental well-being, and have been described in detail by Ryan and Deci [6]. In public-health studies, mental well-being can be used as an umbrella term for various factors relating to global self-esteem, life satisfaction, body image, anxiety, depression and somatic complaints. All these

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variables are interconnected and can influence each other in creating either ill- or well-being. Studies have shown that mental well-being is highly affected by global self-esteem among both adolescents and young adults [7]. A recent study on Norwegian adolescents revealed that 20% of those who dropped out of secondary school did so because of mental ill-being [8]. Global self-esteem can act as an indicator of how individuals deal with the transition between different school levels, the manner in which they manage these life changes and challenges, and how satisfied with life they become [2].

Global self-esteem is an evaluation of one's overall worthiness and is on top of the hierarchical construct of self-esteem [9]. Global self-esteem is derived from individuals' self-evaluation in different domains (e.g. physical self-esteem and academic self-esteem) and sub-domains at lower levels of the hierarchy [9]. It is, in turn, positively associated with both body image satisfaction (the subjective happiness with some or all aspects of one's appearance) and life satisfaction (the indicator of overall quality of life) [10]. Low self-esteem has been linked to increased depression and anxiety, the two most common comorbid disorders in adolescence and young adulthood that often manifest as somatic complaints [10,11]. Anxiety, depression and somatization are well-known psychological factors that share numerous symptoms that can impact daily activities [11].

Gender differences in mental well-being

Studies on self-esteem have revealed mixed results regarding gender differences in adolescence and young adulthood. A large meta-analytic review of both cross-sectional and longitudinal data by Kling et al. [2] found a small variation favouring men, but the most pronounced difference emerged in late adolescence between the ages of 15 and 18. This difference decreased during young adulthood (ages 19–22). Studies on body image, depression, anxiety and somatic complaints have established clear gender differences favouring men [12–14] that seem to persist, even though they diminish through adulthood [2,12]. Studies on life satisfaction, however, indicate no gender differences for either adolescents or young adults [15,16].

The current study

Self-esteem and its development and role in adolescence and adulthood have received substantial interest from researchers for several years [2]. However, full consensus on how self-esteem develops from adolescence through young adulthood has not yet been reached. This is especially due to a lack of longitudinal-based studies covering that particular transition period [17]. Therefore, the aim of this prospective long-term study was to examine the development of self-esteem and other mental well-being variables from the age of 15 to the age of 23, with a specific focus on gender differences.

Materials and method

Design and subjects

Baseline measurements were taken from a national representative cohort of 15 year olds, and a follow-up study was conducted eight years later when participants were 23 years old. Both measurements were conducted between August and January, and the same questions on all mental well-being variables were used. At follow-up, questions on life satisfaction were added to the questionnaire. All study instruments were in Icelandic. The questionnaires were translated into Icelandic and then back-translated into English by a second translator, and that version was vetted by a qualified reviewer.

The largest school districts in Iceland (60%) are located in metropolitan Reykjavik. In an effort to represent the true population of students in both rural and urban areas, 18 schools within metropolitan Reykjavik and from the north-east of Iceland were randomly selected for baseline measures and invited to participate. Sixty per cent of the participants came from the Reykjavik area, and 40% from north-east Iceland. The school system is fundamentally comprised of schools run by the local county councils, and most of them use the same curriculum supervised by the Ministry of Education. Compulsory education in Iceland ends with 10th grade with most 16-year-old adolescents starting their four years of secondary education.

Participation and dropout

A total of 385 participants answered the questionnaire at the age of 15, which was almost 10% of the national population (N=4168) in that age group [18]. Eight years later, 201 answered the questionnaire again. The total drop-out rate was 47.8%, with more women dropping out compared to men (Figure 1). Statistical analysis revealed no differences in mental well-being scores at baseline between those who dropped out and those who did not drop out, independent of gender.

Ethics

The research project was approved by the Icelandic Data Protection Authority according to the Icelandic Act on Processing of Personal Data,

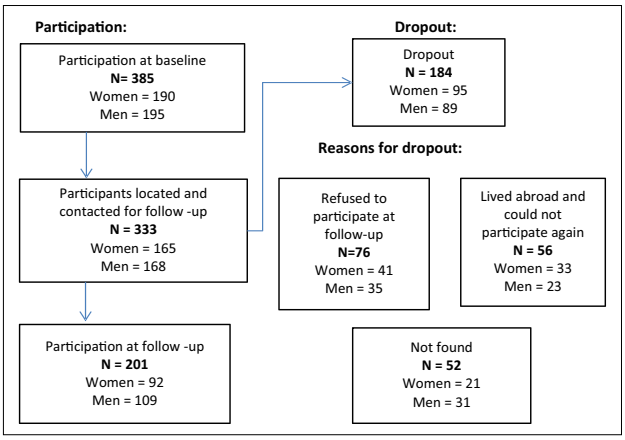

Figure 1. Participation at baseline (age 15) and follow-up (age 23) and reasons for drop-out from the study.

and the Icelandic Bioethics Committee. Written informed consent was obtained from the participants for the current study and their parents before the baseline measurements. Strict procedures were followed to ensure confidentiality.

Measures

Global self-esteem. Global self-esteem (henceforth self-esteem) was at both time points assessed using the Rosenberg Self-Esteem Scale [19]. The scale consists of 10 statements, each rated as negative or positive, with four response options ranging from 0 (strongly disagree) to 3 (strongly agree). Higher scores (⩾15 points) reflect a greater level of self-esteem. The Rosenberg scale has been widely used in measuring self-esteem in young people, and its reliability and validity are well-documented [2]. Cronbach's alpha in this study was 0.89 at baseline and 0.91 at follow-up.

Life satisfaction. Life satisfaction was measured only at follow-up, and Diener's Satisfaction with Life Scale (SWLS) was used [20]. This is a five-item scale designed to measure global cognitive judgements of one's life satisfaction. Participants indicated how much they agreed or disagreed with each of the five items, using a seven-point response option ranging from 1 (strongly disagree) to seven (strongly agree). A healthy score on the standardized SWLS was >20 points. In this study, Cronbach's alpha was 0.88.

Body image. Body image was evaluated at both time points with five questions from the Body and Self-Image subscale of the Offer Self-Image Questionnaire (OSIQ) [21]. Participants were asked how satisfied they were with their body. Other questions were on physical appearance and physical health. All items were rated on a four-point response scale ranging from 1 (not at all true of me) to 4 (true of me). Higher scores reflect greater levels of body image. A healthy score for this body image scale was >13 points. Cronbach's alpha for body image was 0.79 at baseline and 0.80 at follow-up.

Anxiety, depression and somatic complaints. Anxiety, depression and somatic complaints were assessed by the Subscales of the Symptom Checklist 90 (SCL-90) [22]. At both time points, four items were used to measure anxiety, 10 items to measure depression and eight items to measure somatic complaints. They were scored on a five-point Likert scale ranging from 1 (almost never) to 5 (almost always), asking about feelings of anxiety, depression and somatic complaints the preceding week. A healthy score for anxiety was <12 points; for depression, <30 points; and for somatic complaints, <24 points. The midpoint of possible scores on each scale was defined as the cut-off for a healthy versus an unhealthy score. Examples of questions are 'Were you nervous?' for anxiety; 'Did you feel that the future is hopeless?' for depression; and 'Did you have a headache?' for somatic complaints. Cronbach's alpha for baseline anxiety, depression and somatic complaints was 0.74, 0.89 and 0.78, respectively, and for follow-up it was 0.59, 0.88 and 0.74 for the same variables.

Statistics

Means and standard deviations were used when presenting central tendencies and dispersion. A mixed

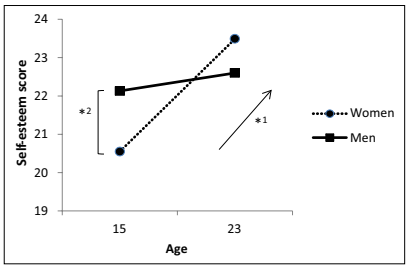

Figure 2. Interaction (gender and age) for self-esteem.
*1=women's self-esteem increased more than men's.
*2=men had higher self-esteem than women at the age of 15; no difference was found at the age of 23.
$p<0.05$.

model analysis of variance for repeated measures was carried out to measure gender difference and longitudinal changes in mean scores for each mental well-being variable (except for life satisfaction, as it was only measured at follow-up). If the interaction between gender and age was found to be statistically significant ($p<0.05$), a Tukey post hoc test was used to compare different pairs of means. An unpaired *t*-test was used to test for differences in life satisfaction between genders at follow-up. Possible differences in mental well-being variables between those who dropped out and those who did non were analysed using unpaired *t*-test. Analysis between drop-outs and non-drop-outs were calculated with Microsoft Excel 2010. All other analysis were calculated using SAS Enterprise Guide, version 4.3 (SAS Institute, Inc., Cary, NC), and the alpha level for significant differences was set at 0.05.

Results

Gender differences

The only gender difference found on the development of mental well-being from adolescence to young adulthood was for self-esteem, that is, age–gender interaction (Figure 2). During the eight-year period between measurements, young women increased their mean score for self-esteem more than young men, $F(1, 182)=8.4$ for interaction, $p=0.004$ (Table I). The results show that adolescent boys had better self-esteem than adolescent girls ($p=0.03$), but no gender difference for self-esteem was found in participants when they reached the age of 23 ($p=0.72$). A score <15 points is classified as 'low self-esteem', and at the age of 15, 9.7% of the boys compared with 14.5% of the girls fell into this category. As 23 year olds, 11.1% of men had low self-esteem, while the same applied to only 3.3% of the women (Figure 3).

Gender difference was found for life satisfaction. Women at follow-up were more satisfied with life than men, $t(198)=2.65$, $p=0.009$. Among the young men, 14.8% were unsatisfied with life compared to 6.5% of the young women (Figure 3). Results for the other mental well-being variables show that men had better scores than women, independent of age, for body image, $F(1, 400)=15.9$, $p<0.001$, anxiety, $F(1, 400)=24.2$, $p<0.001$, depression, $F(1, 400)=13.8$, $p<0.001$, and somatic complaints $F(1, 400)=12.6$, $p<0.001$ (Table I).

Changes in mental well-being

Women's self-esteem increased between the age of 15 and the age of 23 ($p<0.001$), but no difference was found during that same period among men. Participants' anxiety score, independent of gender, decreased, $F(1, 181)=4.0$, $p=0.04$, from the age of 15 to the age of 23, and their somatic complaints became fewer, $F(1, 181)=14.8$, $p<0.001$. No change was found in men's or women's body image or depression scores from adolescence to young adulthood (Table I).

Discussion

The main finding of this study was that women's self-esteem improved significantly more than men's from the age of 15 to the age of 23. The results also indicate that women were more satisfied with life than men were at the age of 23, but men had better scores than women, independent of age, for body image, anxiety, depression and somatic complaints.

It was interesting to discover that the gender differences in self-esteem, found in participants at the age of 15, had disappeared at 23 years of age. That adolescent boys had better self-esteem than adolescent girls is consistent with the literature [2,13]. It is well-documented that women's psychological distress increases much more than men's during adolescence [2,12–14]. Numerous demographic, biological, social and psychological explanations for these gender differences have been proffered [23]. However, finding no gender differences for self-esteem at the age of 23 is inconsistent with earlier findings [24], where men have been found to have better self-esteem than women. It is also at odds with previous results [15] that women at the age of 23 were more satisfied with life than men were. On the other hand, women being more satisfied with life than the men is consistent with the increased self-esteem, from the age of 15 to the age of 23, among the women in this study.

Even though women's self-esteem caught up with men's and the former were more satisfied with life at the age of 23, they had significantly worse scores for

Table I. Mental well-being variables' mean score (*SD*) in women and men at the ages of 15 and 23, and results from mixed model ANOVA.

Gender	Women		Men		ANOVA's *p*-values		
Age	15	23	15	23	Gender	Age	Interaction (gender–age)
Self-esteem	20.6 (6.0)[a]	23.5 (5.2)	22.1 (5.7)[a]	22.6 (6.0)	0.468	<0.001	0.004
Life satisfaction[c]		26.5 (4.9)[b]		24.4 (5.8)[b]			
Body image	14.1 (2.8)[a]	14.8 (2.5)	15.4 (2.7)[a]	15.4 (2.7)	<0.001	0.10	0.11
Anxiety	7.0 (3.0)[a]	6.4 (2.1)	5.7(2.3)[a]	5.5 (2.0)	<0.001	0.04	0.29
Depression	17.3 (6.9)[a]	16.1 (6.1)	14.5 (5.8)[a]	14.7 (5.2)	<0.001	0.40	0.14
Somatic complaints	16.3 (5.6)[a]	14.3 (4.7)	14.0 (4.8)[a]	13.3 (4.4)	<0.001	<0.001	0.07

[a]Gender differences in scores at the age of 15, $p<0.05$.
[b]Gender differences in scores at the age of 23, $p<0.05$.
[c]Life satisfaction was measured only at follow-up.
ANOVA, analysis of variance.

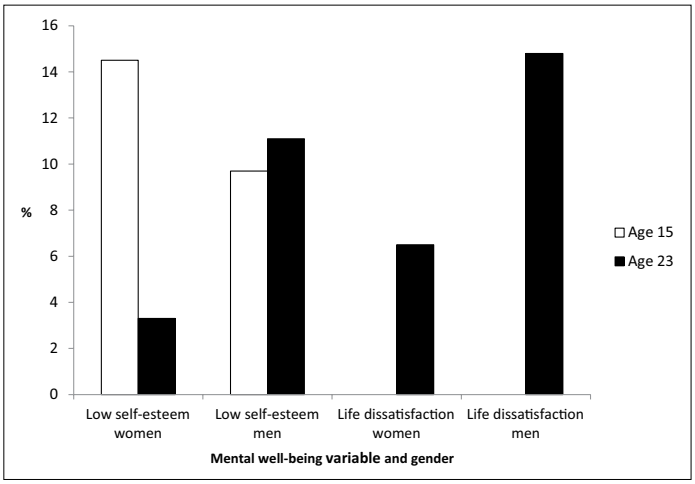

Figure 3. The proportion of women and men at the ages of 15 and 23 with low self-esteem, and dissatisfied with life at the age of 23.

body image, depression and anxiety, and more somatic complaints than the men did, which is in line with previous reports [25]. Since larger proportion of women (75%) than men (62%) in this study were attending secondary school or higher education at age 23, it could be speculated that the schoolwork put an extra strain on women affecting their psychological distress while boosting their self-esteem. The boost of women's global self-esteem through their higher education, as speculated above, was perhaps affected by an increase in their academic self-esteem (a domain specific self-esteem at the second level of the hierarchy of the self-esteem), which then had a positive influence on the global self-esteem (the top level of the hierarchical construct of the self-esteem) [9]. Not surprisingly, we found that more women than men in this study were students. The drop-out rate for Icelandic males from secondary school is one of the highest in the Organization for Economic Co-operation and Development countries (around 30% between the years 2000 and 2009) [26]. In Iceland, secondary school education is one year longer than in the other Nordic countries, and in a recent report [27] from the Ministry of Education in Iceland, only 44% of all students finish their education in the allocated four years. Furthermore, a study in Iceland found that more adolescent boys than girls drop out of school because they do worse academically and their mental well-being is, on average, worse [26]. It could be speculated that this long road (about 14 years of compulsory and then secondary education) before students can start their university education proves somewhat more difficult for Icelandic men than women.

It is worth noting that during the delicate transition period from adolescence to young adulthood, women seem to catch up with men, as a positive transformation occurred in women's general self-esteem. This transformation might also be explained by the economic crisis in Iceland starting in October 2008. It is possible that this financial crisis had more negative effects on young Icelandic men than women, which historically has indeed been shown to be the case [28]. Difference in employment status is also a tempting explanation. All the same, we found similar rates of unemployment among the genders (4–5%) at the age of 23. Nevertheless, Katikireddi et al. reported in their study that the global economic crisis affected men's mental health more than it affected women's, independent of participants' employment status [29].

As mentioned above, an interaction between age and gender was only found for self-esteem. However, there was a tendency for such interaction for body image and somatic complaints ($p>0.05$ but <0.11), indicating that women improved more on those well-being variables than men did. The lack of significant findings likely stems from low power in our data. Although mean scores for all well-being variables were within a healthy range, it is thought-provoking that the proportion of men who had low self-esteem increased about 12% from the age of 15 to the age of 23, whereas the proportion of women who had low self-esteem decreased about 77% during the same period.

To our knowledge, no study has found similar improvement in self-esteem among women but not men between adolescence and young adulthood. The general public, as well as the mass media, have been fascinated by findings of gender differences, as Hyde [30] points out in her meta-analysis of research on psychological gender differences. There she argues for the hypothesis of gender similarities. It is a positive sign that young women are improving their well-being, and our results might give support to Hyde's [30] hypothesis on gender similarities in mental well-being.

Limitations of the study

There are several limitations to the study, such as the use of self-reports for participants' mental well-being, and the use of the midpoint of possible scores on the anxiety, depression and somatic complaints scales to classify scores into healthy and unhealthy ones. It would have improved the study to measure life satisfaction at baseline as well. The drop-out rate is also worth considering. However, the same results were found when excluding subjects from the baseline data who did not participate at follow-up. Similarly, no statistical differences were found on any mental well-being variable at baseline between drop-outs and non-drop-outs. Finally, the study does not allow for causal conclusions, as it simply observed the development as such.

Conclusion

Our findings suggest that the gender differences in mental well-being factors found in adolescents are not as long-lasting as previously believed. Furthermore, the findings advance knowledge of the development of self-esteem and other mental well-being variables from adolescence into young adulthood. Future studies should focus on the causes for the discrepancy in the changes of mental well-being scores from adolescence to young adulthood, that is, the improvement in general self-esteem but not in other variables for women, and more life dissatisfaction among men than women. Since the transition from adolescence into young adulthood involves widespread changes in the educational and social environment and alterations affecting lifelong physical and psychosocial well-being and lifestyle behaviours, further prospective studies are needed to understand the mechanisms underlying the development of mental well-being factors for both genders during this transition period.

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Conflict of interest

The authors declare that there is no conflict of interest.

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Paper 2

The association between physical activity, fitness and body image in adolescence and young adulthood - An eight-year follow-up study

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Abstract

Body image dissatisfaction has been linked with a range of adverse psychosocial outcomes in both sexes and has become an important public health issue. The aim of current study was to examine if physical activity and fitness affect body image differently across sex and age, measured in same participants initially at age 15 and again at age 23. Structural equation modeling was used to examine these associations; covariates included skinfold thickness, body mass index, socioeconomic status, anxiety and depression. For females age 15 and 23, self-reported fitness and depression were found to be related to their body image, and body mass index at the age of 23. For 15 year old males skinfold thickness and aerobic fitness related to their body image, whereas skinfold thickness, depression, body mass index and self-reported fitness did so at age 23. Result suggest intervention methods needed to improve body image might need to be tailored to young peoples' sex and age.

Keywords: Body image, Physical activity, Fitness, Adolescence, Young adult, Follow-up study

Introduction

Body image dissatisfaction is a negative, subjective evaluation of the appearance of one´s body (Stice & Shaw, 2002). During adolescence, individuals go through major physical developmental changes, which are often accompanied by increased awareness of physical appearance and sensitivity to significant others' opinions and feedback, which in turn can lead to the use of more social comparison both regarding bodily abilities and form (Markey, 2010). In Western societies the “thin ideal” is embraced, in which women are portrayed slim, tall and young (Levine & Chapman, 2012), an extremely lean and muscular body symbolizes the perfect body for men (Cafri & Thompson, 2004). Consequently, overweight and obese persons are commonly stigmatized in Western cultures since fatter bodies are regarded as undesirable, and this applies to both sexes (Grogan, 2006, 2008). Notably, although sex differences in the development of body image dissatisfaction are well-established, with a much higher prevalence of dissatisfaction among young women than men (Lawler & Nixon, 2011; Meland, Haugland, & Breidablik, 2007), the comparison to an “ideal” weight or shape as presented in the media seems to be associated with increased dissatisfaction in both women (Grabe, Ward, & Hyde, 2008) and in men (Barlett, Vowels, & Saucier, 2008). Dissatisfaction with one's body can be found among all body sizes, but higher body mass index (BMI) has been found to be related to higher levels of body image dissatisfaction in non-clinical samples (Sarwer, Thompson, & Cash, 2005).

Body image dissatisfaction has been linked with a range of adverse psychosocial outcomes among individuals, including depression, low

self-esteem, eating disorders and obesity (Darby, Hay, Mond, Rodgers, & Owen, 2007; Stice, 2002; Wiederman & Pryor, 2000). Not surprisingly, studies have shown that dissatisfaction in women is more strongly correlated with clinical eating disorders, whereas it has been associated with food supplement abuse and the use of anabolic steroids in men aiming to gain muscle mass (Mellor, Fuller-Tyszkiewicz, McCabe, & Ricciardelli, 2010; Smolak, 2004). According to Mellor et. al. (2010), public health systems in Western countries face enormous financial burden due to hospitalizations for problems associated with body image dissatisfaction, such as eating disorders. Moreover, continued long-term psychological and physical care for patients who dislike their body is needed.

There is a general agreement within the literature that physical activity (PA) has a positive effect on mental well-being of individuals (e.g., depression, anxiety and self-esteem) (McDonald & Hodgdon, 1991; Netz, Tenenbaum, & Sagiv, 1988; Rostad & Long, 1996; Spence, McGannon, & Poon, 2005). Similarly, researchers have proposed, based on their study findings, that exercise might constitute a viable method to improve people´s body image (Pendleton, Goodrick, Poston, Reeves, & Foreyt, 2002; Sundgot-Borgen, Rosenvinge, Bahr, & Schneider, 2002). Gaspar, Amaral, Oliveira, and Borges (2011) found that higher levels of PA in adolescents had a positive effect on body image satisfaction, independent of BMI or sex. In line with these findings are results of the meta-analytic review of Hausenblas and Fallon (2006), which supports the hypothesis that exercise is associated with less body image dissatisfaction across all ages (adolescents, university students, adults, and the elderly). Their review also covered intervention studies, in which exercising subjects reported better body image than the non-exercising controls. PA is needed to promote an increase in fitness (Blair, Cheng, & Holder, 2001). In Ortega, Ruiz, Castillo and Sjostrom´ (2008) review on the association of fitness with several health outcomes in young people, they proposed two possible explanations for the positive effect of fitness on mental well-being. Firstly, improvement in fitness is usually accompaniedwith a visable increase in lean mass and a decrease in fat mass, leading to more positive body image. Secondly, they forwarded the possibility that improved fitness has a direct effect on neurochemicals, like serotonin or endorphins in the brain, that are important for mood elevation.

Current study

Body image dissatisfaction can have diverse negative health outcomes on individuals and seems to represent an increased public health problem. Hence, it is vital to investigate other factors that can impact body image perception, such as PA, body composition, and fitness. Also, it is not only interesting, but also important, to examine whether the same factors

influence body image perception across age and sex to be able to offer the right empowerment tools. As Bucchianeri, Arikian, Hannan, Eisenberg, and Neumark-Sztainer (2013) have pointed out, little is known about how female and male body dissatisfaction changes from adolescence into young adulthood. The aim of the study was to analyze the change in study variables from age 15 to age 23, and to examine the relationship between objectively measured PA and fitness (measured in two ways, both objectively and subjectively) to body image across sex and age. Based on the findings listed above, i.e. that exercise has been associated with a more positive body image across all ages (Hausenblas & Fallon, 2006), and previous research findings (Ortega et al., 2008) regarding the positive effect fitness has on overall health, we hypothesized that aerobic fitness and PA would have a stronger relation to body image than the self-reported fitness.

Method

Participants and Procedure

A longitudinal design with two measurement points was used. Baseline measurements were taken in a sample of 15 years olds from a national representative cohort in Iceland, and follow-up measures on the same group were conducted eight years later when participants had reached 23 years of age. Both first and second measurement phases were carried out between August and January. All study instruments were in Icelandic.

The baseline study sample consisted of 385 adolescents (aged 15), N = 190 girls and 195 boys. At follow-up a total of 201 participants (aged 23), 92 females, and 109 males, were recruited for the second measurement. Total dropout from baseline to follow-up was 47.8%, of which 19.7% refused to participate again, 14.5% lived abroad and could therefore not participate again, and 13.5% were not located. No significant differences were found in body image scores, PA, aerobic fitness, self-reported fitness or BMI at baseline between dropouts and participants, but those who dropped out had higher skinfold thickness than non-dropouts.

Approximately 90% of the estimated 290,000 inhabitants of Iceland in 2003, and about 85% of the estimated 320,000 inhabitants in 2011 were of Norse and Celtic origin (Statistics Iceland, e.d.-a). Furthermore, 87% and 77% of the population belonged to the Lutheran State Church in 2003 and 2011 respectively (Statistics Iceland, e.d.-b). Due to this homogeneity, variables such as race, ethnicity, and religion were not included in the analyses of this study. Socioeconomic status (SES) was not adjusted for at baseline, due to missing data on the SES measure (which was based on a questionnaire that parents filled out). Analyses at follow-up were adjusted for SES, based on parents education status as reported by participants. About the same proportion of female and male

participants were unemployed at follow-up, or 4% (Gestsdottir et al., 2015).

The research project was approved by the Icelandic Bioethics Committee and the Icelandic Data Protection Authority according to the Icelandic Act on Processing of Personal Data. Written informed consent was obtained from participants and from their parents before baseline measurements. Strict procedures were followed to ensure confidentiality.

Measures

Primary measures

Body image. Body image was evaluated at both time points with five questions from the Body and Self-Image Subscale of the Offer Self-Image Questionnaire (OSIQ) (Offer, Ostrov, Howard, & Dolan, 1992). Even though the OSIQ is designed for the age group of 13-19 years, it was used in this study for consistency purpose like it has been done in other studies (e.g. Dunlop, Burns and Bermingham, 2001). In the current study participants were asked how well they agreed with the following five statements: "I'm satisfied when I think about how my body will look in the future", "I usually think I'm unattractive and not good looking", "I'm satisfied with how my body looks", "I'm satisfied with the changes that my body has undergone in the last few years", and "I feel strong and healthy". All items were rated on a four-point response scale, where 1 = Not at all true of me, 2 = Not true of me, 3 = True of me, and 4 = Very true of me. Scoring of the second question was reversed, so higher overall scores on this scale reflected better body image. Total scores on this version of the scale ranged from 5 to 20 points. Higher score represent healthier body image. The internal consistency of the body image scores at baseline was Cronbach's α=0.79 and α=0.80 at follow-up.

Aerobic and Self-reported fitness. Aerobic fitness, the objective measure of fitness, was assessed using the maximal cycle ergometer test on a Monark 839E bike (Monark Exercise AB, Vansbro, Sweden). This is an indirect test of maximal oxygen uptake and was developed in Denmark by Hansen, Froberg, Nielsen, and Hyldebrandt (1989). Each participant cycled at a predetermined workload: 40 W for women and 50 W for men, which increased by the same amount every three minutes until voluntary exhaustion was reached, or until the pedal rate of 40 rpm could not be maintained. The participants were advised that they could quit the test at any time, but were verbally encouraged to give their best effort and cycle as long as they possibly could. During each test, heart rate was measured with a Polar heart rate monitor (Polar Vantage, Polar Electro, Kempele, Finland). In the last 15 s of every stage (every time before the workload increased), the participants' ratings of perceived exertion were obtained on Borg´s scale, ranging from 6 (7 = very, very easy) to 20 (19 = very,

very hard) (Borg, 1998). Total cycling time was measured in seconds with a stopwatch. Maximal power output per unit of body weight (W/kg) was calculated for each participant and used as an indicator of cardio-respiratory fitness to compare results. The test was considered maximal if two out of three criteria were met: a) heart rate within 5% of the age-predicted maximum; b) ratings of perceived exertion of at least 19; or c) a researchers' subjective evaluation of exhaustion. This test has been validated both for adolescents (Arngrimsson, Sveinsson, & Johannsson, 2008; Eisenmann, 2007) and adults (Eriksen, Tolstrup, Larsen, Grønbæk, & Helge, 2014).

Self-reported fitness, a subjective measure of fitness, was estimated with the following question, “How good is your fitness?”, with four response options: 1 = bad; 2 = okay; 3 = good; and 4 = excellent. This question was taken fromthe Health behavior in school-aged children (HBSC) study (ref.), The HBSC study has for the last 30 years conducted cross-sectional studies on young people across several European countriesaimed to gain insight into several aspects of young people´s psychosocial functioning, health and well-being.

Physical activity. Participants PA was assessed using Actigraph activity monitors (Manufacturing Technologies Inc. (MTI), model GT3X), which were carried on the right hip for one week, from the time they woke up until they went to sleep. Presented data is the total time per day, from a weighted average of weekdays and weekend days, spent in moderate-to-vigorous activity (threshold 2000 counts per minute (cpm) for age 15, and 2020 cpm for age 23 (Troiano et al., 2008)). A detailed protocol for measurements with accelerometers has been described previously (Magnusson, Sveinsson, Arngrimsson, & Johannsson, 2008). This particular type of accelerometer gives a reliable and valid measure of PA (Brage, Wedderkopp, Franks, Andersen, & Froberg, 2003) but is unable to measure all types of activity, e.g. swimming.

Covariates

Anthropometry. Standing height was measured to the nearest 0.1 cm with a stadiometer (Seca model 217, Seca Ltd. Birmingham, UK), and body weight was measured on a balance scale (Seca model 813, Seca Ltd. Birmingham, UK) to the nearest 0.1 kg with participants wearing light clothes. BMI was calculated from participants' weight and height (kg/m2).

Skinfold thickness was measured with a Lange skinfold caliper (Lange, Beta Technology Incorporated, Cambridge, USA) in four places on the left side of the body (subscapular, triceps, biceps, and suprailiac). All skinfold measure ments were taken three times, the mean value of the two closest measurements was calculated, and the sum of four skinfolds (mm) was used for analysis. Trained

personnel performed all measurements at both time points.

Anxiety and Depression. Anxiety and depression were assessed by two subscales of the Symptom Checklist 90 (SCL-90) (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974). At both time points, four items were used to measure anxiety and 10 items for depression. They were scored on a five-point Likert-scale rated from 1 (almost never) to 5 (almost always), asking about feelings of anxiety and depression in the preceding week. Healthy score was defined as below 12 points for anxiety and under 30 points for depression Examples of questions are 'Were you nervous' for anxiety and; 'Did you feel that the future is hopeless' for depression. Cronbach's alpha for baseline anxiety and depression was 0.74 and 0.89, respectively. At follow-up, Cronbach's alpha was 0.59 and 0.88 for these same variables.

Statistical analyses

Test of normality and analyses of variables´ change across time was calculated using SAS Enterprise Guide, version 4.3 (SAS Institute Inc., Cary, NC) and comparisons between baselines dropouts and non-dropouts were calculated with Microsoft Excel 2010. Study variables were all found to be normally distributed. Descriptive statistics are presented as means and standard deviations (SD). Differences in study variables and covariates from age 15 and age 23 were analysed with paired t-tests for males and females separately. Difference in self-reported fitness was assessed with Kendall´s Tau b for the four categories.The alpha level for significant differences was set at 0.05 in all analyses.

Structural equation modeling (SEM) and factor analyses were conducted with Mplus software version 7.3 (Muthén & Muthén, 1998-2012). SEM was used to evaluate the influence of PA, aerobic fitness and self-reported fitness at age 15 and age 23 on body image. Covariates in the model consisted of BMI, skinfold thickness, anxiety and depression for both age groups, and SES for the follow-up group. The model included latent variables for body image (five items), depression (10 items), and anxiety (four items). As well as the following observed variables: aerobic fitness, self-reported fitness, PA, BMI, skinfold thickness, and SES. Confirmatory factor analysis was used in the construction of all latent variables, and also to test the fit of the model to the observed data. The recommended (Geiser, 2013) cut-off for fit indices used were Standardized Root Mean Square Residual (SRMR), $0 \leq SRMR \leq 0.1$; Comparative Fit Index (CFI), $0.95 \leq CFI \leq 1.00$; and Root Mean Square Error of Approximation (RMSEA), $0 \leq RMSEA \leq 0.08$. The relationship between a latent variable and a measured item was expressed as factor loadings. The structural model consisted of the latent variable of body image that was regressed (linear regression) on the

observed variables (aerobic fitness, self-reported fitness and PA) and above mentioned covariates. The analyses for the measurement model and the structural model were conducted simultaneously, but separately for sex at each age group. Maximum likelihood was used to deal with missing values.

Results

Changes in study variables

Descriptive statistics of the variables in the structural model (Figure 1) and covariates are presented in Table 1. No difference was found in body image between baseline and follow-up measure ments, within sex. Aerobic fitness was significantly lower at follow-up both in females ($t(46) = 8.9$; $p < 0.001$) and males ($t(58) = 10.9$; $p < 0.001$). The was a 2.8% drop per year on average in aerobic fitness among females and 2.6% drop among males. Fewer female ($r\tau=0.36$; $p < 0.001$) and male ($r\tau=0.20$; $p < 0.05$) participants perceived their fitness to be good or excellent at age 23 compared to their assessments at age 15. The differences manifested especially in the percentage of those that rated their fitness as excellent; one-fifth of the female participant did so at age 15, whereas none of them made that claim at age 23. Similarly, at age 15, a third of the males self-reported their fitness as excellent, whereas only 6% did so at age 23 (Table 1). The difference in PA between measure-ments was quite profound, as it fell by almost half amongst the females ($t(33) = 6.6$; $p < 0.001$) or by 6.2% per year on average and 60% for the males ($t(29) = 6.1$; $p < 0.001$) or 7.6% per year on average between baseline and follow-up. Anxiety, depression and skinfold thickness did not change, but BMI was significantly higher at follow-up among females ($t(91) = 9.2$; $p <0.001$) and males ($t(108) = 16.2$; $p < 0.001$).

Structural model

The correlations between body image, fitness and PA measures in the structural model and covariates can be viewed in Table 2. A SEM based factor analysis was conducted on the latent body image construct. The five observed items were shown to have loadings ranging from 0.53 -0.75 (Figure 1), and the factor loadings for the 10 observed indicators of the latent depression variable ranged from 0.30-0.92. The fit of the proposed structural model (Figure 1) to the observed data was tested within the full sample and across sex at both time points (Table 3). Goodness-of-fit indices for total sample at baseline and follow-up generally gave acceptable fit: with SRMR being 0.045 for baseline measurements and 0.055 for follow-up; CFI being 0.923 for baseline and 0.911 for follow-up measurements; and RMSEA being 0.081 for baseline and 0.098 for follow-up measure-ments. The structural model for the total sample accounted for 31.2% of the variance in body image in adolescence and 26.0% of the variance

in body image in young adulthood (Table 3). In the first step of the SEM analysis, body image was regressed on the primary measures, in the second step of the SEM analysis covariates were included in the regression.

Factors affecting body image in adolescents

When body image was regressed on PA and both fitness variables among 15-year-old females, only self-reported fitness was significantly associated with body image. Factor analysis revealed factor loadings between 0.46-0.79 for the five items that manifested body image (Figure 1). Once covariates (BMI, skinfold thickness, anxiety and depression) were added to the model, depression in addition to self-reported fitness, were shown to have a significant relationship with body image among females. Factor analysis revealed factor loadings between 0.40 – 0.81 for the ten items manifesting depression. Of the two, self-reported fitness had a stronger relation to body image (β=0.447,$p < 0.001$), than depression (β= -0.392,$p < 0.001$). Put differently, by an increase of one standard deviation in self-reported fitness, their body image increased by 0.45 standard deviation. Self-reported fitness and depression explained 46.3% of the variance in body image.

When body image was regressed on PA and both fitness variables among 15-year-old males, aerobic fitness was the only variable having a significant relation to body image. After adding the covariates to the model, skinfold thickness and aerobic fitness had a significant relation to the body image of males. Skinfold thickness had a stronger association with body image than aerobic fitness, skinfold thickness´ standardized regression slope was -0.331 ($p < 0.001$) whereas for aerobic fitness it was 0.295 ($p = 0.004$). These two variables accounted for 25.8% of the variance in the body image of males.

Factors affecting body image in young adults

When regressing body image on both fitness variables and PA, self-reported fitness stood out as the only significant variable among 23-year-old females. When adding covariates (BMI, skinfold thickness, depression, anxiety and SES) to the model, BMI, depression and self-reported fitness were shown to have a significant relation to body image. Factor analysis in the structural equation model revealed factor loadings between 0.51 - 0.892 for the items manifesting body image (Figure 1) and between 0.351 - 0.884 for items manifesting depression. BMI had the strongest association with body image (β =-0.446; $p < 0.001$). Self-reported fitness had the second strongest association with body image ($\beta = 0.368$; $p < 0.001$), and depression (β = -0.200; $p = 0.027$). Together the three variables explain 48.9% of the variance in females´ body image.

Among 23-year-old males, self-reported fitness had the only significant association with body image

when body image was regressed on the primary measures. When covariates were added to the model the following four variables, skinfold thickness, BMI, depression and self-reported fitness had a significant relation to males´ body image. Factor loadings for the items manifesting body image ranged from 0.47 - 0.79 (Figure 1) and factor loadings for the items manifesting depression ranged from 0.33 - 0.84.

Skinfold thickness had the strongest relation to body image with a standardized regression slope equal to -0.455 ($p = 0.002$), depression having the second strongest relation by having regression slope equal to -0.371 ($p < 0.001$), then BMI with a regression slope equal to 0.343 ($p = 0.016$), and finally self-reported fitness having standardized regression slope estimate equal to 0.322 ($p < 0.001$). Together the three variables accounted for 42.2% of the variance in males´ body image at age 23.

Discussion

We found no evidence of change in body image between the ages of 15 and 23 although both fitness and PA decreased during the study period. The decline found in PA mirrors the results found in other studies that measured PA objectively (Corder et al., 2015). Dumith, Gigante, Domingues, and Kohl´s (2011) systematic review revealed a decline in PA (measured both objectively and by self-report) by 7% during the adolescent years, with more drop in PA among 13-16 year old boys (7% drop in PA) as compared with girls (6% drop in PA). These results are in line with our results, where the 7.6% drop in PA per year on average between baseline and follow-up among males was more than the 6.2% drop per year among females´ PA. The reduction in aerobic fitness found in the current study, which presumably is due to decline in PA over the study period, is in agreement with previous findings (Tomkinson & Olds, 2007). The decrease in participants´ aerobic fitness paralleled their perception of fitness, but the percentage of participants evaluating their fitness subjectively as being excellent fell dramatically between the ages of 15 and 23.

We expected that PA and aerobic fitness would have the strongest association with body image. In opposition to our hypothesis, PA was not found to be significantly related to body image. This was shown to be the case both among males and females and in both age groups. In light of previous studies showing the impact of PA on individuals' health and well-being (Penedo & Dahn, 2005), our results are somewhat surprising. There may be several explanations for these contradictory findings. Firstly, most studies revealing a positive effect of PA on mental well-being have relied on self-reports, but in the current study we used accelerometers that provide a much more accurate and detailed measure of PA than a self-report. Secondly, our finding could be attributed to a lack of

power, as only 92 (of the 195) males and 81 females (of the 190) at the age of 15, and 79 males (of the 109) and 69 femals (of the 92) at the age of 23, fulfilled the criteria of carrying the accelerometer on their hips for a whole week. Regarding aerobic fitness, it was interesting to find that it did only have significant association with body image among adolescent males. It could be speculated since skinfold thickness, and aerobic fitness were the only two variables significantly associated with body image among 15-year-old males that their ability and activity in sports are important as being physically active should boost their muscular masculine cultural body ideal.

Skinfold thickness in males at age 23 still had the strongest association with their body image, just like when they were 15 year old. However, depression and self-reported fitness did also relate to their body image in young adulthood whereas aerobic fitness did not. It is imperative to bear these differences in mind when trying to formulate a strategy for promoting individuals´ body image, which in itself can be construed as a vital public health initiative. The results from current study indicate that different intervention programs are needed to boost body image across sex at different time points in an individual's life.

According to social comparison theory (Festinger, 1954) individuals compare themselves to others on various dimensions to self-evaluate. The "ideal" body shape continuously presented in the mass media is unrealistic and unattainable for most people. In the current study, female participants´ body image was related most strongly to how they perceived their fitness followed by depression, whereas no association was found with aerobic fitness, PA and body composition. The way adolescent females construct self-perceptions of their bodies seems to be more important than their actual body size and shape. In young adulthood, body shape and size seem to be important to females as well their self-preceptions. BMI, which had the strongest association with body image, was negatively related to body image, while self-reported fitness and depression were positively and negatively associated with body image,respectively.

Interestingly, the variance in body image explained by variables associated with body image increased in males from 25.8% at age 15 to 42.2% eight years later. For females the increase was less pronounced, the variance in body image explained by the variables associated with body image was 46.3% at age 15 but 48.9% at age 23. These results indicate that both objective and subjective measures of variables are needed to explain the variance in body image, and, therefore, various methods are needed to boost body image.

For many years, researchers have focused on body image dissatisfaction

in women (Martin Ginis, Strong, Arent, Bray, & Bassett-Gunter, 2014; Stice & Whitenton, 2002), but as Sladek, Engeln, and Miller (2014) have pointed out, the issue has largely been ignored regarding men.

An important feature of the current study is its longitudinal tracking of the same participants measuring them at two-time points in their lives, in adolescence at age 15, and in young adulthood at age 23. Hence, we are in the position to examine whether the relationship of PA and fitness to body image is fixed or dynamic across this important age period. In the study of Bucchianeri et al. (2013) on the longitudinal changes in body image dissatisfaction in two cohorts, the younger cohort was measured in young adolescence (13 years) and again in young adulthood (23 years), while the older cohort was measured in middle adolescence (16 years) and again in their middle young adulthood (26 years). Their results revealed a rise in body image dissatisfaction from baseline to follow-up among both sexes and in both cohorts, and this increase was associated with an increase in BMI during the same period. However, when BMI was controlled for, the upward trend in body dissatisfaction became non-significant. Conversely, in the current study, no change was seen in mean body image scores from adolescence to young adult-hood, across sex, although similar increases in BMI were observed. One possible explanation for the difference in findings regarding body image scores could be the use of different measurement tools used in these two studies. In Bucchianeri et al. (2013), body image was assessed with the Body Shape Satisfaction Scale and self-reported height and weight were used to determine BMI, whereas in current study BMI was assessed objectively and the Offer Self-Image Scale used to measure body image. Moreover, the strong relation between increased BMI and increased body image dissatisfaction reported by Bucchianeri et al. (2013) could be explained by the fact that a large proportion of their participants were overweight (BMI > 25 kg/m2), but in current study, little less than one-fourth of the participants was classified as such.

Indeed, long-term analyses indicate that body image dissatisfaction in early and middle adolescence predicts later signs of mental distress, i.e. depressive symptoms and lower global self-esteem (Holsen, Kraft, & Roysamb, 2001; Johnson & Wardle, 2005; Stice & Bearman, 2001). Persons with more favourable body image are obviously more likely to take better care of their bodies and to be more comfortable about exercising in public. Body image may, therefore, be seen as a key factor for the development of both mental and physical health (Darby et al., 2007; Stice, 2002; Wiederman & Pryor, 2000).

Strength and limitation

The main strength of the current study is the longitudinal design, which allowed tracking the same individuals

over two time-points in their life. Moreover, we measured PA objectively, and we provided measures of both self-reported physical fitness as well as objective measures of aerobic fitness. By using SEM analysis, we were able to account for the measurement error of latent variables in the analysis. A weakness of the study is that we did not have a measure of SES for baseline measures. However, SES measured at follow-up did not have any association with body image at follow-up. The low number of participants that had valid PA measure is also a weakness that may have limited the power of the study.

In future studies, it would be interesting to test if the direction of the association between the study variables is the other way around than we hypothesized as Jensen and Steele (2009) suggested, or that body image is one of the determinants of physical activity. It would also be interesting to study the longitudinal effect of PA and fitness on body image, from adolescence to young adulthood.

Conclusion

Female participants´ body image was related to how they perceived their fitness (both in adolescence and young adulthood), therefore, enhancement of their self-perceived fitness may seem a viable approach to obtain better body image satisfaction. On the other hand, adolescent male participants´ body image was most affected by their aerobic fitness. Hence, enhancing their aerobic physical capability may prove effective for increasing their body satisfaction. In young adulthood, male participants´ body image was influenced by both body composition and how they perceived their fitness. Therefore, one could speculate that by improving body composition they would see their fitness also as enhanced, and thereby be more satisfied with their body image. This study indicates the males and females need to be approached differently when it comes to efforts to improve their body image in adolescence and young adulthood.

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Tables:

Table 1. Participants´ characteristics, for primary variables and covariates.

Sex	**Women**				**Men**			
Age	**15**	**min-max**	**23**	**min-max**	**15**	**min-max**	**23**	**min-max**
Body image	14.1 (2.8)	6.0-20.0	14.8 (2.4)	8.0-20.0	15.4 (2.7)	5.0-20.0	15.4 (2.7)	7.0-20.0
Aerobic fitness[a]	3.1 (0.4)	2.0-3.8	2.4 (0.5)	1.5-3.6	3.8 (0.6)	1.5-4.9	3.0 (0.5)	1.7-4.1
Physical activity[b]	51.1 (19.7)	12.0-117.7	25.9 (15.3)	3.6-70.0	72.4 (29.4)	12.7-154.9	28.2 (16.8)	1.8-87.9
Self-reported fitness								
Bad (%)	33 (17.8)		18 (20.0)		19 (10.1)		13 (12.0)	
Okay (%)	34 (18.4)		45 (48.9)		36 (19.1)		45 (41.7)	
Good (%)	81 (43.8)		29 (31.5)		75 (39.7)		43 (39.8)	
Excellent (%)	37 (20.0)		0		59 (31.2)		7 (6.5)	
BMI[c]	21.1 (2.9)	15.0-31.5	23.5 (3.7)	17.7-33.9	21.0 (3.0)	16.2-35.8	24.8 (4.0)	18.3-40.6
Sum of skinfold[d]	66.7 (22.8)	24.0-148.5	63.9 (25.9)	20.0-154.0	46.9 (25.5)	17.8-127.0	46.2 (21.2)	17.0-117.0
Anxiety	7.0 (3.0)	4.0-16.0	6.4 (2.1)	4.0-13.0	5.7 (2.3)	4.0-20.0	5.5 (2.0)	4.0-13.0
Depression	17.3 (6.9)	10.0-43.0	16.1 (6.1)	10.0-39.0	14.5 (5.8)	10.0-50.0	14.7 (5.2)	10.0-39.0

Data is presented as mean (sd), range, and count (%)

[a]Measured in W/kg

[b]Presented as total minutes in moderate-vigorous activity

[c]BMI = Body mass index (kg/m^2)

[d]Sum of four skinfold measured (tricep, bicep, subscapular, suprailiac) measured in mm

Table 2. Correlation of primary variables and covariates at baseline (age 15) and follow-up (age 23).

Age 15	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Body image Item 1											
Body image Item 2	.407*										
Body image Item 3	.368*	.495*									
Body image Item 4	.365*	.343*	.558*								
Body image Item 5	.294*	.369*	.466*	.460*							
Aerobic fitness	.097	.306*	.430*	.282*	.329*						
S-R fitness	.167*	.253*	.328*	.237*	.454*	.433*					
Physical activity	.011	.066	.090	.126	.148	.473*	.246*				
BMI	-.040	-.104*	-.222*	-.078	.013	-.383*	-.156*	-.088			
Skinfold thickness	-.052	-.207*	-.343*	-.174*	-.104*	-.702*	-.324*	-.360*	.774*		
Anxiety	-.169*	-.230*	-.274*	-.128*	-.233*	-.261*	-.236*	.012	.026	.115*	
Depression	-.326*	-.371*	-.397*	-.208*	-.322*	-.335*	-.284*	-.056	.021	.113*	.644*
Age 23	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Body image Item 1											
Body image Item 2	.407*										
Body image Item 3	.524*	.492*									
Body image Item 4	.458*	.283*	.585*								
Body image Item 5	.457*	.267*	.511*	.506*							
Aerobic fitness	.111	.124	.333*	.238*	.352*						
S-R fitness	.233*	.107	.415*	.327*	.499*	.564*					
Physical activity	-.002	.117	.241*	.145	.137	.344*	.251*				
BMI	-.092	-.075	-.292*	-.178*	.049	-.314*	-.160*	-.104			
Skinfold thickness	-.159*	-.155*	-.391*	-.311*	-.172*	-.649*	-.363*	-.224*	.699*		
Anxiety	-.282*	-.231*	-.249*	-.153*	-.228*	-.113	-.154*	-.035	-.125	-.034	
Depression	-.243*	-.341*	-.288*	-.242*	-.258*	-.092	-.176*	-.234*	-.235*	-.014	.571*

*$p < 0.05$; S-R fitness = self-reported fitness; BMI = body mass index

Table 3. Fit statistic for proposed structural model.

	Total sample age 15	Females age 15	Males age 15	Total sample age 23	Females age 23	Males age 23
RMSEA	**0.081**	**0.095**	**0.070**	**0.098**	**0.111**	**0.092**
CFI	**0.923**	**0.899**	**0.093**	**0.911**	**0.879**	**0.923**
SRMR	**0.045**	**0.052**	**0.054**	**0.055**	**0.069**	**0.055**
R^2	**0.312**	**0.352**	**0.168**	**0.260**	**0.305**	**0.224**

RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; SRMR = Standardized Root Mean Square Residual

Figures:

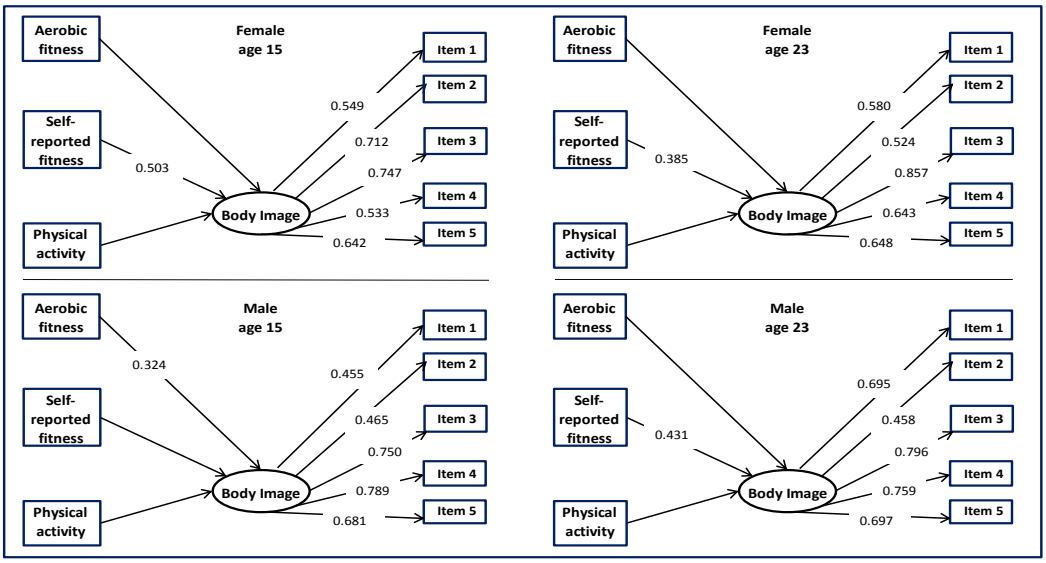

Figure 1. Structural models with statistically significant ($p < 0.05$) standardized estimates.

Paper 3

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Do aerobic fitness and self-reported fitness in adolescence differently predict body image in young adulthood? An eight year follow-up study

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ABSTRACT

Aim: To study whether fitness level in adolescence predicts body image in young adulthood.
Methods: Longitudinal study in which n = 385 participants were measured at age 15 and n = 201 at age 23. Fitness was assessed both objectively and subjectively. Body image was evaluated with the Offer Self-Image Questionnaire. Cross-lagged structural equation model was used to study whether fitness at age 15 predicted body image at age 23, covariates included sex, body mass index, physical activity, and socioeconomic status.
Results: Aerobic fitness at age 15 was the strongest predictor ($\beta = 0.372$; $p < 0.05$) of body image at age 23. Baseline body image ($\beta = 0.214$; $p < 0.05$) had also a significant effect, but self-reported fitness and covariates did not relate to body image at follow-up. The structural model explained 22.1% of variability in body image at follow-up. During the eight-year study period both aerobic and self-reported fitness decreased but body image remained the same.
Conclusion: Objectively measured fitness in adolescence is an independent predictor of body image in young adulthood, whereas self-reported fitness is not. Strong fitness in adolescence is important for a healthy body image later in life.

1. Introduction

Adolescence is a time of major development in the physical and sexual maturity of individuals. During this transition period, both sexes become more aware of their body which often leads to a comparison to others, both in function and appearance (Markey, 2010). Commonly accompanying physical development is the emergence of body dissatisfaction, a disliking and disparaging of one's body, which is present both in girls (Ackard & Peterson, 2001) and boys (O'dea & Abraham, 1999). The comparison to an "ideal" weight or shape presented in the media can also be a risk factor for increased dissatisfaction with one's body (Williamson, Gleaves, Watkins, & Schlundt, 1993). In Western media the "thin ideal" is embraced, where women are expected to be thin, tall and young, with at least moderately large breasts (Levine & Chapman, 2012), whereas the perfect body for men is supposed to be extremely lean and muscular (Cafri & Thompson, 2004). Not surprisingly, studies have shown that body image dissatisfaction in women is more strongly correlated with clinical eating disorders, whereas, in men, it has been associated with the use of anabolic steroids and food supplement abuse to gain weight (Mellor, Fuller-tyszkiewicz, McCabe, & Ricciardelli, 2010; Smolak, 2004). Body dissatisfaction is believed to contribute to maladaptive eating behaviors and dieting which often lead to significant eating disturbances (Shroff & Thompson, 2006). Negative body image and eating disturbances are recognized as significant public health concern in Western world. Hospitalizations due to eating disorders and body dissatisfaction pose a huge financial burden on the public health system, as well as the costs associated with need for long-term physical and psychological treatment following such disturbances (Mellor et al.,

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2010). Dissatisfaction with one's body can be found among all body sizes, however higher body mass index (BMI) has been found to be related to more body image dissatisfaction in non-clinical samples (Sarwer, Thompson, & Cash, 2005).

A healthy body image is important to the overall well-being of an individual as body image dissatisfaction has been linked with a range of adverse psychosocial consequences, including depression (Wiederman & Pryor, 2000), low self-esteem (Paxton, Neumark-Sztainer, Hannan, & Eisenberg, 2006), and obesity (Darby, Hay, Mond, Rodgers, & Owen, 2007). According to Homan and Tylka (2014), positive body image indicates behaviors and attitudes that acknowledge healthy acceptance of and show gratitude for the body. As body image is of such pivotal importance to both physical and mental well-being, there is an urge for better knowledge concerning factors influencing how both sexes feel and think about their bodies. Also, instead of focusing just on problematic behaviors and attitudes, there is a need for understanding and emphasizing positive body image.

One important aspect of body image is the actual physical health of the body. Physical activity (PA) plays a significant role in this regard, as it is thought to influence a healthy body image development in adolescents. The positive effect of PA on both physical and mental well-being is well documented (Blair, Cheng, & Holder, 2001; Kelly et al., 2011). High PA levels have been found to be a strong predictor of higher levels of physical fitness in adolescents (Haugen, Ommundsen, & Seiler, 2013; Sveinsson, Arngrimsson, & Johannsson, 2009) as well as adults (Physical Activity Guidelines Advisory Committee, 2008). However, very little is known about how these factors affect body image. Hakkinen et al. (2010) have highlighted the lack of evidence of the association between physical fitness and health-related quality of life (a person's perceived physical and mental well-being) in young adults. In adults, studies on the relationship between physical fitness and mental well-being have indicated an increase in overall wellness with good physical fitness (Hakkinen et al., 2010). Less is known about the association between physical fitness and body image, and to our knowledge, nothing exists on the long-term effect of physical fitness on body image.

Due to the public health threat that follows disturbed body image and a need for knowledge on what boosts positive body image, the goal of this study was to evaluate the influence of aerobic fitness (an objective measure of fitness) and self-reported fitness (a subjective measure of fitness) during adolescence (at age 15) on body image in young adulthood (at age 23), whilst taking into account the following covariates: sex, BMI, PA, and socioeconomic status (SES). Based on previous research findings (Ortega, Ruiz, Castillo, & Sjostrom, 2008) regarding the positive effect physical fitness has on health, we hypothesized that an objectively measured fitness would have a stronger long-term effect on body image than the subjectively measured fitness.

2. Methods

2.1. Design and subjects

A longitudinal design with two measurement points was used. Baseline measurements were taken in a sample of 15 years old national representative cohort in Iceland, and follow-up measures on the same cohort were conducted eight years later when participants had reached 23 years of age. Both first and second measurement phases were carried out between August and January. All study instruments were in Icelandic. Participants started by answering a questionnaire about their body image and level of fitness, and then their anthropometrics were measured; finishing with the aerobic fitness test.

Approximately 90% of the estimated 290,000 inhabitants of Iceland in 2003 were of Norse and Celtic origin (Statistics Iceland, e.d.-a) and 87% of the population belongs to the Lutheran State Church (Statistics Iceland, e.d.-b). Due to this homogeneity, variables such as race, ethnicity, and religion, which are often used in researches in the other countries, were not included in the analyses in this study. SES was estimated by parents' education that participants reported on at follow-up. Baseline SES was not adjusted for due to missing data on the SES measure at baseline (which was based on a questionnaire that parents filled out at baseline).

2.2. Participation and dropout

In an effort to represent the true population of rural and urban areas in Iceland 18 schools in the vicinity of Reykjavik (the capital) and from the North and East of Iceland were invited to participate for the baseline measurements. Sixty percent of participants came from the Reykjavik area, and 40% came from Northeast Iceland. The baseline study sample consisted of 385 adolescents, with 190 girls and 195 boys which was almost 10% of the national population ($N = 4168$) in that age group (Statistics Iceland). A total of 201 participant, 92 females and 109 males were measured eight years later. For the recruitment of the follow-up study a letter was sent to all baseline participants ($N = 385$) informing them about the follow-up and that they would receive a phone call (most people in Iceland are registered in the phonebook), where further details would be given. When participants were reached by the phone and if they agreed to participate again, they were given an appointment for the measurements and reminded of it by text message 24 h prior to the appointment. Larger proportion of females (75%) than males (62%) were attending secondary school or higher education at follow-up and equal proportion (4–5%) of males and females reported being unemployed at the follow-up.

Total dropout from baseline to follow-up was 47.8% with more females dropping out compared to males (Fig. 1). No significant differences were found in body image score, aerobic fitness, self-reported fitness, PA and BMI at baseline between dropouts and participants. At both time points, no differences were found in body image score between those who finished the aerobic fitness test and those who did not.

2.3. Ethics

The research project was approved by the Icelandic Data Protection Authority according to the Icelandic Act on Processing of Personal Data and the Icelandic Bioethics Committee. Written informed consent was obtained from participation and from their parents before the baseline measurements. Strict procedures were followed to ensure confidentiality.

2.4. Measures

2.4.1. Body image

Body image was evaluated at both time points with five questions from the *Body and Self-Image subscale of the Offer Self-Image Questionnaire* (OSIQ) (Offer, Ostrov, Howard, & Dolan, 1992). The Icelandic version of the scale was developed and tested in Young People surveys, yielding acceptable reliability and validity (Bjarnason & Thorlindsson, 1993). In studies, e.g. (Asgeirsdottir, Ingolfsdottir, & Sigfusdottir, 2012; Vilhjalmsson, Kristjansdottir, & Ward, 2012), on Icelandic samples, internal consistency has been found to be between 0.74 and 0.77, and high factor loading of the five items (ranging from 0.65 to 0.82) support that the five item OSIQ is a single factor with all items being important. Even though the OSIQ is designed for the age group 13–19 years old it was used

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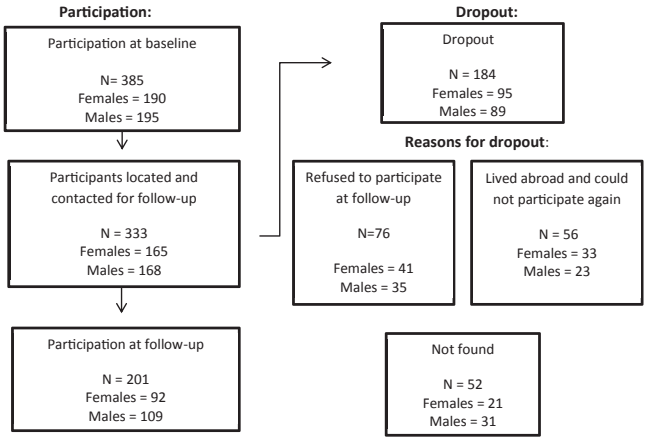

Fig. 1. Participation at baseline (age 15) and follow-up (age 23) and reasons for dropout from the study.

in this study for consistency purpose like it has been done in other studies e.g. Dunlop, Burns, and Bermingham (2001). In this study participants were asked how well they agreed with the following five statements: "*I'm satisfied when I think about how my body will look in the future*", "*I usually think I'm unattractive and not good looking*", "*I'm satisfied about how my body looks*", "*I'm satisfied with the changes that my body has undergone in the last few years*", and "*I feel strong and healthy*". All items were rated on a four-point response scale, where *1 = Not at all true of me*, and *4 = True of me*. Scoring of the second question is reversed for higher scores to reflect a greater level of body image. Total scores on this version of the scale ranged from 5 to 20 points. A healthy score for this body image scale was above 12 points (the midpoint between scores of 5 and 20). The internal consistency of the body image scores at baseline was Chronbach's $\alpha = 0.79$ and $\alpha = 0.80$ at follow-up.

2.4.2. Aerobic and self-reported fitness

Aerobic fitness, the objective measure of fitness, was assessed using the maximal cycle ergometer test on a Monark 839E bike (Monark Exercise AB, Vansbro, Sweden). This test is an indirect test of maximal oxygen uptake and was developed in Odense, Denmark by Hansen, Froberg, Nielsen, and Hyldebrandt (1989). Each participant cycled at a predetermined workload: 40 W for women and 50 W for men, which increased by the same amount every three minutes until voluntary exhaustion was reached or until pedal rate of 40 rpm could not be maintained. The participants were advised that they could quit the test at any time but were verbally encouraged to give their best effort and cycle as long as they possibly could. During each test, heart rate was measured with a Polar heart rate monitor (Polar Vantage, Polar Electro, Kempele, Finland). In the last 15 s of every stage (every time before the workload increased) the participants' ratings of perceived exertion were obtained on Borg's scale, ranging from 6 (7 = very, very easy) up to 20 (19 = very, very hard) (Borg, 1998). Total cycling time was measured in s with a stopwatch. Maximal power output per unit of body weight (W/kg) was calculated for each participant and used as an indicator of CRF to compare results. The test was considered maximal if two out of three criteria were met: a) heart rate within 5% of the age-predicted maximal heart rate; b) ratings of perceived exertion of at least 19; or c) a researchers' subjective evaluation of exhaustion. This test has been validated for adolescents (Arngrimsson, Sveinsson, & Johannsson, 2008; Eisenmann, 2007) and adults (Eriksen, Tolstrup, Larsen, Grønbæk, & Helge, 2014).

Self-reported fitness, the subjective measure of fitness, was estimated with the following question from the questionnaire, "*How good is your physical fitness?*", with four response options: 1 = bad; 2 = okay; 3 = good; and 4 = excellent. This question has previously been used in the *Health behavior in school-aged children* (HBSC) study, which is a cross-national research study aimed at gaining insight into young people's well-being for the last 30 years, and has been taken over by the World Health Organization (HBSC, ed).

2.4.3. Physical activity

Participants' PA was assessed using Actigraph activity monitors (Manufacturing Technologies Inc. (MTI)) model GT3X, which they carried on their right hip for one week from the time they woke up until they went to sleep. Data presented in this study is the total time (minutes per day) from weighted average of weekdays and weekend days spent in moderate-to-vigorous activity. A detailed protocol of measurements with accelerometers has been described previously (Magnusson, Sveinsson, Arngrimsson, & Johannsson, 2008). This particular type of accelerometer gives a reliable and valid measure of PA (Brage, Wedderkopp, Franks, Andersen, & Froberg, 2003) but is unable to measure all types of activity, e.g. swimming.

2.4.4. Body composition

Body composition was estimated by BMI. BMI was calculated from participants' weight and height (kg/m^2). Standing height was measured to the nearest 0.1 cm with a stadiometer (Seca model 217, Seca Ltd. Birmingham, UK), and body weight was measured on a balance scale (Seca model 813, Seca Ltd. Birmingham, UK.) to the nearest 0.1 kg with participants wearing light clothes.

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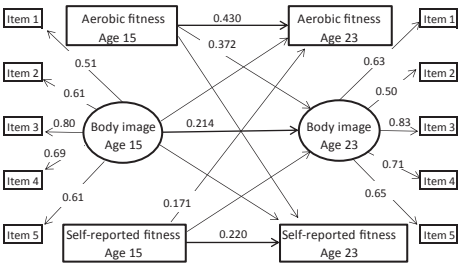

Fig. 2. Cross-lagged structural equation model with significant standardized estimates and factor loading of the measurement model.

2.5. Statistical analyses

Study variables were examined for distributional properties, and all were normally distributed. Descriptive statistics is presented as means and standard deviations (SD). A paired t-test was used to analyze changes in scores from age 15 to age 23 for all variables except for self-reported fitness where Kendall's Tau b was calculated for the four categories. One way ANOVA was conducted to analyze differences in mean aerobic score between each of the four categories of self-reported fitness, and post-hoc test Tukey (HSD) was used to examine significant differences between categories. A Structural equation model (SEM) analysis was conducted to analyze the data.

Cross-lagged SEM was used to evaluate the influence of the manifest variables (aerobic fitness and self-reported fitness, measured at age 15) on the latent variable (body image measured at age 23). Covariates tested in the model were the following:, sex (0 = females, 1 = males), BMI and PA at age 15 and SES at age 23. In the measurement model the latent variables (body image at age 15 and 23) are factors from a confirmatory factor analysis of the five measured variables (five manifest variables on body image) from the questionnaire. The relationship between a latent variable and a measured variable is expressed as factor loadings. Main variables in the cross-lagged model, i. e. fitness and body image (Fig. 2), were regressed on covariates in accordance with Little (2013) (as SES was only measured at follow-up it was considerate a covariate for variables measured at follow-up). The analyses of the measurement model and the cross-lagged structural model were conducted simultaneously, and maximum likelihood was used to deal with missing values.

SEM analyses were conducted with the M*plus* software version 7 (Muthén & Muthén, 1989). Other analysis were calculated using SAS Enterprise Guide, version 4.3 (SAS Institute Inc., Cary, NC), and the alpha level for significant differences was set at 0.05.

3. Results

3.1. Descriptive statistics and the measurement model

Descriptives of the status and intercorrelation of variables in the structural model are presented in Table 1. Means and standard deviations for measured variables at baseline and follow-up can be seen in Table 2. Aerobic fitness decreased during the study period and fewer rated their fitness as "excellent" at follow-up than did so at baseline. Self-reported fitness was also categorized into four levels in accordance with the four response options. The 26% who reported their fitness as "excellent" at age 15, had higher aerobic fitness than those 42% who reported their fitness as "good", the 19% that reported it as "okay", and the 14% that reported it as "bad", all p's < 0.05 (Table 2). As seen in Fig. 3 self-reports of fitness and level of aerobic fitness were in agreement as mean aerobic fitness was on average 23% higher among those who reported it as "excellent" than those who reported it as "bad".

Factor loadings in the measurement model between the latent construct (body image at age 15 and at age 23) and the measured variables (variables 1–5 at each time point) were between 0.51 and 0.80 at baseline and 0.50–0.83 at follow-up (Fig. 2).

3.2. Cross-lagged model

A cross-lagged model analyzing the longitudinal predictor-outcome relationship between both fitness variables measured at age 15 and body image measured at age 23 had the following acceptable goodness-of-fit indices: RMSEA = 0.061; CFI = 0.854; SRMR = 0.081. The proportion of variance in body image at follow-up which the cross − lagged model accounted for was 22.1% ($R^2 = 0.221$). In the cross-lagged design body image at age 15 did have significant ($p < 0.05$) auto-regressive effect on body image at age 23 but no cross-lagged effect on aerobic fitness or self-reported fitness at age 23 (Table 3). Aerobic fitness at age 15 had significant ($p < 0.001$) auto-regressive effect on aerobic fitness and a cross-lagged effect on body image at age 23 (Table 3); and self-reported fitness at age 15 did only have significant auto-regressive effect on self-reported fitness at age 23 ($p < 0.05$) (Table 3). None of the covariates related to body image at age 23 (Table 3). The correlation between the residual variables (residual error) for the baseline measurements of body image and aerobic fitness were statistically significant, $r = 0.313$ ($p < 0.001$), as well as the correlation between the residual variables for the follow-up measurement of body image and aerobic fitness, $r = 0.230$ ($p < 0.05$).

4. Discussion

The aim of this study was to examine the long-term influence of objectively (aerobic fitness) and subjectively (self-reported fitness) assessed fitness in adolescence on body image satisfaction in young adulthood. To our knowledge, this is the first study to examine the longitudinal effect of differential fitness measures on body image and to use a structural equation modeling. As we hypothesized, a long-term association was found between fitness and body image. Aerobic fitness in adolescence was a stronger predictor of body image satisfaction in young adulthood than self-reported fitness. In fact, self-reported fitness as well as the covariates, did not have significant effect on the body image at follow-up. The only other variable than aerobic fitness to have significant effect on body image at age 23 was body image measured at age 15. Moreover, aerobic fitness was a stronger predictor of body image at follow-up than body image measured at baseline. One can speculate that self-reported fitness might be a proxy for body composition instead of being a measure of fitness and does therefore not have significant effect on body image, just like BMI. A support for this speculation is the evidence that adolescents frequently relate fitness to appearance and to "looking good" (Haugen et al., 2013). One has to keep in mind that the self-reported measure of fitness was only one question in the questionnaire, and perhaps a more robust variable assessing self-report of fitness would have resulted in a significant association. However, those reporting their fitness "bad" had the worst aerobic fitness and those reporting their fitness as "excellent" had the best aerobic fitness. In accordance with our hypothesis, aerobic fitness was a stronger predictor of body image than self-reported fitness and it was even a stronger predictor of body image at follow-up than body image measured at baseline. This latter

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Table 1
Correlations, means and standard deviations for the variables in the structural model.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1) BI 15 v1													
2) BI 15 v2	0.404*												
3) BI 15 v3	0.370*	0.494*											
4) BI 15 v4	0.364*	0.342*	0.557*										
5) BI 15 v5	0.293*	0.370*	0.471*	0.454*									
6) BI 23 v1	0.352*	0.245*	0.325	0.291	0.249								
7) BI 23 v2	0.141	0.212*	0.212	0.101	0.158	0.383*							
8) BI 23 v3	0.233*	0.209*	0.247	0.161	0.142	0.509*	0.482*						
9) BI 23 v4	0.127	0.146	0.139	0.099	0.197	0.466*	0.302*	0.595*					
10) BI 23 v5	0.151	0.208	0.191	0.068	0.222	0.437*	0.289*	0.501*	0.508*				
11) AE fit 15	0.100	0.306*	0.430*	0.282*	0.330*	0.270*	0.360*	0.332*	0.256*	0.338*			
12) SR fit 15	0.165*	0.253*	0.329*	0.237*	0.451*	0.209*	0.246*	0.297*	0.268*	0.343*	0.443*		
13) AE fit 23	0.033	0.108	0.271*	0.078	0.148	0.096	0.100	0.364*	0.324*	0.315*	0.603*	0.380*	
14) SR fit 23	0.102	0.024	0.175*	0.067	0.226*	0.234*	0.110	0.417*	0.354*	0.479*	0.286*	0.347*	0.537*
Mean	3.075	2.875	2.774	2.987	3.031	3.217	3.315	2.836	2.771	2.961			
SD	0.719	0.838	0.855	0.719	0.742	0.539	0.676	0.743	0.783	0.711			

*$p < 0.05$; BI 15 v1 = body image age 15 variable 1 etc; BI 23 v1 = body image age 23 variable 1 etc; AE fit 15 = aerobic fitness at age 15; SR fit 15 = self-reported fitness at age 15; AE fit 23 = aerobic fitness at age 23; SR fit = self-reported fitness at age 23; SD = standard deviation.

Table 2
Descriptive statistics, means and SDs for variables at baseline and follow-up.

Variable	Age 15	Age 23	Score difference
Body image	14.9 (2.8)	15.1 (2.6)	$p = 0.379^{\ddagger}$
Aerobic fitness – (W/kg)	3.5 (0.6)	2.8 (0.6)	$p < 0.001^{\ddagger}$
Body mass index – (kg/m^2)	20.8 (2.9)	24.2 (3.9)	$p < 0.001^{\ddagger}$
Physical activity (min per day)	60.5 (25.8)	27.2 (16.1)	$p < 0.001^{\ddagger}$
Self-reported fitness % (N)			$p < 0.001^{*}$
Bad	13.9 (52)	15.5 (31)	
Okay	18.7 (70)	45.0 (90)	
Good	41.7 (156)	36.0 (72)	
Excellent	25.6 (96)	3.5 (7)	

‡Paired t-Test; *Kendall's Tau-b; SD = standard deviation.

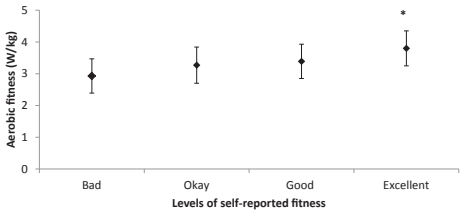

Fig. 3. Mean aerobic fitness score in each of the four groups of self-reported fitness at age 15. *Participants reporting their fitness as excellent have significantly higher aerobic fitness, $p < 0.05$.

finding is especially interesting because mean aerobic fitness level decreased during the eight year period but mean body image score did not change during that same period. It was also interesting to find what the cross-lagged model revealed about the change in aerobic fitness and body image from adolescence to young adulthood. Although all autoregressive effects were statistically significant (which indicates a significant proportion of individual differences remained stable over time for body image), the differences were not completely stable over time as some cross-lagged coefficients were significant and accounted thus for some of the body image score at follow-up. Aerobic fitness at age 15 did significantly predict body image at age 23 and was the only variable that had significant cross-lagged coefficient towards body image at follow-up. This supports our hypothesis and strengthens our

Table 3
Standardized coefficients (β) and standard errors (SE) for cross-lagged structural equation model, significant covariate effect only shown.

Paths	β	S.E.
Auto-regressive paths		
Body image age 15 → Body image age 23	0.214*	0.100
Aerobic fitness age 15 → Aerobic fitness 23	0.430*	0.108
Self-reported fitness age 15 → Self-reported fitness age 23	0.220*	0.085
Cross-lagged paths		
Body image age 15 → Aerobic fitness age 23	−0.094	0.078
Body image age 15 → Self-reported fitness age 23	−0.062	0.090
Aerobic fitness age 15 → Body image age 23	0.372*	0.128
Aerobic fitness age 15 → Self-reported fitness age 23	0.035	0.127
Self-reported fitness age 15 → Body image age 23	0.185	0.095
Self-reported fitness age 15 → Aerobic fitness age 23	0.171*	0.077
Covariate effect		
Sex → Aerobic fitness age 15	0.491*	0.046
Sex → Body image age 15	0.165*	0.063
BMI age 15 → Body image age 15	−0.125*	0.055
BMI age 15 → Aerobic fitness age 15	−0.311*	0.044
BMI age 15 →Self-reported fitness age 15	−0.068*	0.078
PA age 15 → Self-reported fitness age 23	0.345*	0.105
PA age 15 →Aerobic fitness age 23	0.187*	0.090
PA age 15 → Body image age 15	0.265*	0.078
PA age 15 → Aerobic fitness age 15	0.324*	0.055
PA age 15 → Self-reported fitness age 15	0.403*	0.069

*$p < 0.05$; BMI = body mass index; PA = physical activity.

interpretation of the data that aerobic fitness has the strongest long-term influence on body image.

Even though it is not clear at what point body image becomes reasonably stable (Smolak, 2004), the maintenance of body image over the eight years despite decrease in aerobic fitness could be explained by participants' maturity as they worry less about their looks with increased maturity. Our results mirror the results of others which indicate that the importance of body appearance seems to decrease with increasing age (Frisen, Lunde, & Berg, 2015; Tiggemann, 2004). Hence, these overall results indicate that aerobic fitness in adolescence, especially when assessed objectively, marks an important, influential factor for a healthier body image in young adulthood. Although the model explained only little over 20% of the variance in body image at age 23, it takes a person relatively little effort to increase his or her aerobic fitness and thereby increase their body image – even for long-term. The findings of this study advance the knowledge of the association between aerobic fitness and body image from adolescence to young adulthood. Indeed, Ortega et al. (2008) have pointed out in a review of the literature

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that studies investigating the relationship between physical fitness and mental health in young people are lacking.

Lindwall, Ljung, Hadžibajramović, and Jonsdottir (2012) examined how self-reported PA and aerobic fitness in adult men and women relate to anxiety, depression and burnout. They found that PA but not aerobic fitness was related to the mental health factors. These cross-sectional findings are inconsistent with findings from the current longitudinal study. The few cross-sectional and intervention studies that have been conducted on the association between fitness and mental well-being (mostly depression and anxiety) have nevertheless shown a positive effect of good and improved fitness on mental well-being. A study among Spanish adolescents aged 14–15 reported, for instance, a strong association between self-concept and physical fitness (endurance and strength). Exercise among women has been shown to improve their body satisfaction and affect, independent of what level of body dissatisfaction women have (LePage & Crowther, 2010). DiLorenzo et al. (1999) found in their study on individuals between the ages of 18 and 39 that psychological benefits gained from a 12- week program that increased fitness were maintained at one year follow-up, independent of increased participation in PA. Importantly, the result of three meta-analyses (Campbell & Hausenblas, 2009; Hausenblas & Fallon, 2006; Reel et al., 2007) assessing the effects of different types of exercise intervention on body image have indicated that exercise-training programs are effective for improving body image, but the majority of previous studies have though been based on mostly female samples.

It is well-established, as mentioned in above literature that PA and good physical fitness have a positive effect on mental well-being. How one influences the other is difficult to say, but Ortega et al. (2008) have indicated a two possible underlying mechanisms explaining the relationship between physical fitness and mental well-being: a) the decrease in fat mass and increase in lean mass, which are usually associated with increased physical fitness, are quite visible to people, which enhances their body image; and b) improvements in physical fitness could have a direct effect on neurochemicals in the brain like endorphins and serotonin that serve to uplift mood that leads to more positive view on one body. These two explanations seem to explain a short term or cross-sectional influence better than the long-term influence of physical fitness on body image. A better longitudinal explanation could be that physical fitness influences body image, which then influences self-esteem and higher self-esteem then encourages healthy exercise routines. Self-esteem constitutes a hierarchical construct with global self-esteem at the top. Global self-esteem is derived from individuals' self-evaluation in different domains (e.g., physical self-esteem and academic self-esteem) (Rosenberg, Schooler, Schoenbach, & Rosenberg, 1995). Global self-esteem has been found to be positively associated with body image (Patel, Flisher, Hetrick, & McGorry, 2007; Siegel, Yancey, Aneshensel, & Schuler, 1999) and body image satisfaction considered to be one of the most important factor boosting global self-esteem (Fox, 1998; Rosenberg et al., 1995; Shavelson, Hubner, & Stanton, 1976). Good fitness can hopefully lead to healthy exercise habits and thereby improve body image, which then results in a decrease in the public health threat that eating disturbances have become due to body dissatisfaction. This suggestion of theoretical influence of fitness on body image that results in higher self-esteem could be an appropriate area for future research. Another reason for focusing on self-esteem in future research is the statistically significant correlation of medium size found between the residual variables which indicates that there is a small amount of shared variance in body image and aerobic fitness scores at the same occasion of measurement that is not explained by the cross-lagged model and perhaps the unexplained variance is based on influence from participants' self-esteem.

Unsurprisingly, cross-sectional studies among adolescents have found associations between BMI and body image dissatisfaction (Banitt et al., 2008; Presnell, Bearman, & Stice, 2004), and between obesity and body dissatisfaction (Schwartz & Brownell, 2004), given that being unhappy with body size and shape is a common concern for adolescents. In the current study the same cross-sectional association between BMI and body image at age 15 was observed, whereas no long-term association was found between these two variables (i.e., BMI in adolescence had no relation with body image in young adulthood). In the light of these findings, one can speculate that BMI at a one-time point in life does not affect body image later in life. This may relate well to the proposed idea of Barlow, Kohl, Gibbons, and Blair (1995) regarding *fat* but *fit*, i.e. that within each fatness category, a good aerobic fitness weakens the risk of developing a disease. There is limited evidence regarding the *fat* but *fit* theory on mental well-being outcomes (Veses et al., 2014). The current findings may represent evidence that being *fat* but *fit* affects mental well-being as well as it does for physical well-being, given that aerobic fitness at age 15 predicted body image at age 23, independent of body composition. PA did not have any significant long-term effect on body image, probably due to lack of power in the data as only 164 participants of the 385 measured at baseline had a valid measure on PA. It is, however, important to keep in mind what Etnier, Nowell, Landers, and Sibley (2006) have pointed out that to be able to observe cognitive benefits of PA, changes in aerobic fitness have to take place. Furthermore, the PA needs to reach a certain intensity for it to affect aerobic fitness and then have cognitive benefits.

From a mental health perspective, it is important to study what factors sustain a positive body image in individuals, given the importance of body image plays for general health and well-being, especially global self-esteem. Many studies (Fox, 1997, 1999; Harter & Jackson, 1993) have indicated that body image is positively correlated with self-esteem and this association is believed to be especially strong during adolescence (Harter, 1999; Shapka & Keating, 2005). The intense focus on body shape and size starts at an extremely vulnerable time in individuals' life, when adolescents face rapid social, cognitive and physical changes, their personal identity is formed, and health-related behaviors that tend to be stable throughout life are established (Baranowski et al., 1997; Markey, 2010). Over the last 40 years the time from the onset of puberty to obtaining an independent responsible role in society has increased and has never before been as long as in the 21st century (Sawyer et al., 2012). This widening gap between puberty and attaining adult social and financial independence has been used to explain growing mental health problems and unhealthy behavior among adolescents and young adults (Patton & Viner, 2007). PA and increased physical fitness can heavily shape these behaviors (Gore et al., 2011; World Health Organization, 2004) and boost healthy body image, which is important for both physical and mental well-being.

Further thoughts for future research on the data is the possibility to analyze changes in the data per se with SEM and study what predicts a change in body image not only prediction across time as current research question is based on. It would also be very interesting to study what factors mediate or moderate the association between fitness and body image, both cross-sectionally as well as longitudinally.

4.1. Strength and limitations

The main strength of the current study is the longitudinal design and that we are able to account for measurement error by using SEM. We were also capable of comparing the effects of objective

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and subjective assessments of fitness on body image and no study, to our knowledge, has examined the long-term effect of fitness (measured in two different ways) on body image. Due to the considerably small sample size, separate analyses by sex were not conducted when the associations between fitness and body image were analyzed.

5. Conclusion

The present findings support the presence of a positive effect of aerobic fitness in adolescence on body image eight years later. It also adds to current literature by examining the longitudinal effect of fitness on body image, showing that better aerobic fitness in adolescence predicts a positive body image in young adulthood, independent of sex, SES, PA and body composition. In the light of these finding, it may be important to encourage adolescents to stay active, so their aerobic fitness does not decrease too dramatically during these critical molding years in their lives. Good aerobic fitness is likely to affect individual's overall well-being and by that benefit young people through the transition from adolescence to young adulthood.

Conflict of interest

The authors declare that there is no conflict of interest.

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Appendix A: Questionnaire

Questions used in the study:

1. Ertu karl eða kona?

- ☐ Karl
- ☐ Kona

2. Hvaða ár ertu fædd/ur?

- ☐ 1988
- ☐ 1994
- ☐ Annað, hvaða ár? _____

3. Hverjir búa á sama heimili og þú?

Merktu við allt sem við á. (Ef þú býrð á mörgum stöðum svarar þú fyrir aðalheimili).

- ☐ Ég bý ein/n
- ☐ Eiginmaður minn, sambýlismaður eða kærasti
- ☐ Eiginkona mín, sambýliskona eða kærasta
- ☐ Faðir minn, stjúpfaðir eða tengdafaðir
- ☐ Móðir mín, stjúpmóðir eða tengdamóðir
- ☐ Systkini mín, stjúpsystkini eða fóstursystkini
- ☐ Börn yngri en átján ára á mínu framfæri
- ☐ Aðrir fjölskyldumeðlimir, ættingjar eða óskyldir einstaklingar

4. Hver er menntun þín?

Merktu við allt sem við á.

- ☐ Grunnskólapróf
- ☐ Stúdentspróf
- ☐ Iðnréttindi/starfsréttindi
- ☐ Háskólapróf
- ☐ Önnur

5. Hvaða námi ætlar þú að ljúka?

Merktu við allt sem við á.

- ☐ Grunnskólaprófi
- ☐ Stúdentsprófi
- ☐ Iðnréttindum/ starfsréttindum
- ☐ Háskólaprófi
- ☐ Öðru

6. Hver er/var menntun föður þíns?

Merktu við allt sem við á.

- ☐ Grunnskólapróf
- ☐ Stúdentspróf
- ☐ Iðnréttindi/starfsréttindi
- ☐ Háskólapróf
- ☐ Önnur

7. Hver er/var menntun móður þinnar?

Merktu við allt sem við á.

- ☐ Grunnskólapróf
- ☐ Stúdentspróf
- ☐ Iðnréttindi/ starfsréttindi
- ☐ Háskólapróf
- ☐ Önnur

20. Myndir þú segja að líkamlegt þrek (úthald) þitt væri...?

- ☐ Framúrskarandi
- ☐ Gott
- ☐ Þokkalegt
- ☐ Lélegt

27. Hversu oft varðst þú var/vör við eftirfarandi vanlíðan eða óþægindi <u>síðastliðna viku</u>? Merktu í <u>einn</u> reit í <u>hverjum lið.</u>

	Nær aldrei	Sjaldan	Stundum	Oft	Nær alltaf
a) Höfuðverk	☐	☐	☐	☐	☐
b) Svima	☐	☐	☐	☐	☐
c) Verk í baki	☐	☐	☐	☐	☐
d) Ógleði eða ólgu í maga	☐	☐	☐	☐	☐
e) Doða eða sting einhvers staðar í líkamanum	☐	☐	☐	☐	☐
f) Verk í maga	☐	☐	☐	☐	☐
g) Liðverki	☐	☐	☐	☐	☐
h) Skjálfta	☐	☐	☐	☐	☐
i) Verki í höndum eða fótum	☐	☐	☐	☐	☐
j) Taugaóstyrk	☐	☐	☐	☐	☐
k) Skyndilegrar hræðslu án nokkurrar ástæðu	☐	☐	☐	☐	☐
l) Þú varst uppspennt(ur)	☐	☐	☐	☐	☐
m) Þú varst leið(ur) eða hafðir lítinn áhuga á því að gera hluti	☐	☐	☐	☐	☐
n) Þú hafðir litla matarlyst	☐	☐	☐	☐	☐
o) Þér fannst þú einmana	☐	☐	☐	☐	☐
p) Þú grést auðveldlega eða langaði til að gráta	☐	☐	☐	☐	☐
q) Þú áttir erfitt með að sofa eða sofna	☐	☐	☐	☐	☐
r) Þú varst niðurdregin(n) eða dapur/döpur	☐	☐	☐	☐	☐
s) Þú varst ekki spennt(ur) fyrir að gera neitt	☐	☐	☐	☐	☐
t) Þér fannst þú hægfara eða hafa lítinn mátt	☐	☐	☐	☐	☐
u) Þér fannst framtíðin vonlaus	☐	☐	☐	☐	☐
v) Þú hugsaðir um að fyrirfara þ	☐	☐	☐	☐	☐

28. Hversu vel eiga eftirfarandi fullyrðingar við um þig?

Merktu í einn reit í hverjum lið

	Á mjög vel við um mig	Á frekar vel við um mig	Á frekar illa við um mig	Á mjög illa við um mig
a) Þegar ég hugsa um hvernig ég muni líta út í framtíðinni er ég ánægð(ur)	☐	☐	☐	☐
b) Mér finnst ég oftast vera ófrí(ur) og óaðlaðandi	☐	☐	☐	☐
c) Ég er ánægð(ur) með líkama minn	☐	☐	☐	☐
d) Ég er ánægð(ur) með þær líkamlegu breytingar sem hafa átt sér stað hjá mér undanfarin ár	☐	☐	☐	☐
e) Mér finnst ég vera sterk(ur) g hraust(u	☐	☐	☐	☐

50. Hér fyrir neðan eru ýmsar staðhæfingar um hvað þér finnst um sjálfa/n þig.

Merktu í einn reit í hverjum lið.

	Mjög samm ála	Frekar samm ála	Frekar ósammá la	Mjög ósammá la
a) Ég er almennt ánægð/ur með sjálfa/n mig	☐	☐	☐	☐
b) Stundum finnst mér ég einskis virði	☐	☐	☐	☐
c) Mér finnst ég hafa marga góða eiginleika	☐	☐	☐	☐
d) Ég get gert margt jafn vel og flestir aðrir	☐	☐	☐	☐
e) Mér finnst ég ekki geta verið stolt(ur) af mörgu	☐	☐	☐	☐
f) Stundum finnst mér ég sannarlega vera gagnslaus	☐	☐	☐	☐
g) Mér finnst ég vera a.m.k. jafn mikils virði og aðrir	☐	☐	☐	☐
h) Ég vildi að ég gæti borðið meiri virðingu fyrir sjálfum/sjálfri mér	☐	☐	☐	☐
i) Allt í allt finnst mér ég vera misheppnaður/misheppnuð	☐	☐	☐	☐
j) Ég hef jákvæða afstöðu til sjálfs/sjálfrar mín	☐	☐	☐	☐

55. Hversu sammála eða ósammála ert þú eftirfarandi fullyrðingum?

Merktu í einn reit í hverri línu.

	Mjög ósammála	Ósammála	Frekar ósammála	Hvorki né	Frekar sammála	Sammála	Mjög sammála
a) Líf mitt er að flestu leyti nálægt því sem ég óska mér	☐	☐	☐	☐	☐	☐	☐
b) Aðstæður lífs míns eru frábærar	☐	☐	☐	☐	☐	☐	☐
c) Ég er ánægð(ur) með lífið	☐	☐	☐	☐	☐	☐	☐
d) Hingað til hef ég fengið það mikilvægasta sem ég vil í lífinu	☐	☐	☐	☐	☐	☐	☐
e) Ef ég gæti lifað lífi mínu upp á nýtt myndi ég næstum engu breyta	☐	☐	☐	☐	☐	☐	☐