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Master Thesis

The influence of growth and maturation on injury and illness in Norwegian youth athletes

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ABSTRACT

Background

Factors related to pubertal growth and maturation in adolescence have received increasing attention over the last decades. In contrast to other studies, this study includes athletes of both genders, and from both team- and individual sports.

Method

303 youth athletes were prospectively monitored for growth, maturation and self-reported health problems for 13 weeks. Generalised Poisson regression models were used to model growth rate and maturation on health problem variables collected through weekly distribution of the Oslo Sports Trauma Research Questionnaire on Health Problems.

Results

The relationship between maturity status and severity score was non-linear in boys ($p < 0.001$) and in girls ($p < 0.001$). The relationships with severity score of substantial health problems was non-linear in boys ($p < 0.001$) and non-linear in girls ($p < 0.001$). Peak estimated severity scores, duration of health problems and full time-loss were observed between 86.8 and 92.1 % Percent of Adult Height in boys, and above 97.8 % in girls. The relationships with maturity status and duration of health problems were non-linear in boys ($p = 0.003$) and in girls ($p < 0.001$). The relationships with growth rate and severity score in boys was linear and positive ($p < 0.001$), and non-linear in girls ($p < 0.001$). Girls with growth rates above 7.2cm/year reported higher severity score ($p < 0.001$), longer duration ($p < 0.0001$), higher full time-loss ($p = 0.0001$) and total time-loss ($p < 0.001$) compared to those with growth rates under 7.2cm/year. Boys with growth rates above 7.2.cm/year reported higher severity score ($p < 0.001$), longer duration ($p < 0.001$), more full time-loss ($p < 0.001$), partial time-loss ($p = 0.0002$), and total time-loss ($p < 0.0001$) compared to those with growth rates under 7.2cm/year.

Conclusion

Maturity status and higher growth rate can be related to severity, duration, and type of self-reported health problems in boys and in girls, but studies of longer duration, a more evenly distributed sample and subsequent statistical measures is needed to conclude further around the details of these relationships.

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THEORY AND BACKGROUND

Health and injury in youth athletes

There is a positive association between physical and mental health benefits and participation in sports among youths (Bailey et al., 2018; Hallal et al., 2006; Pascoe et al., 2020; Strong et al., 2005). Together with the potential negative consequences in athletic development, athletes not participating in sports due to a health problem, will also miss out on these potential health benefits (Bergeron et al., 2015; Maffulli et al., 2010). In longer term, the negative health consequences can become prevalent for the athletes, and injuries in adolescence can proceed a reason for drop-out and a lower level of physical activity in later years (Maffulli et al., 2010; Ward et al., 2007). Moreover, injuries can result in a significant loss in both training and competition, in addition to negatively affect the young athletes' development (Bergeron et al., 2015; Ward et al., 2007). Furthermore, injuries among young athletes may also make them more vulnerable to future injuries and long-term health problems in adulthood (Maffulli et al., 2010). Hence, prevention of injuries should be a priority for young athletes and their support device.

A previous study from Norway found a weekly prevalence of health problems among youth athletes competing in a variety of sports to be more than 40 % (Moseid et al., 2018). Furthermore, the same study found that the average weekly prevalence of substantial health problems causing profound changes in participation and performance was 25 %. In another more recent published Norwegian study, including young male and female football players, the weekly prevalence of self-reported health problems was calculated to approximately 65 % (Dalen-Lorentsen et al., 2021). Moreover, studies investigating health problems in sports like ice-hockey and alpine skiing found a weekly prevalence of health problems of 25 and 42 %, respectively (Nordstrøm et al., 2021; Schoeb et al., 2020). In the same studies, substantial health problems had a prevalence of 16 % among the young male ice-hockey players, and 20 % among the young alpine skiers. When delving deeper in to these data on health problems and combining data on different sports, illness, acute injuries, and overuse injuries were responsible for roughly the same amount of health problems (Moseid et al., 2018). Importantly, the distinct characteristics of the sports seem to affect the type of injuries that are being reported (Dalen-Lorentsen et al., 2021; Moseid et al., 2018; Nordstrøm et al., 2021; Schoeb et al., 2020).

Also, while injury surveillance has become a standard practice in youth elite sports, the methods used to register and define injuries vary between studies (Goldberg et al., 2007). Adding to this discussion, a recent study investigating injury burden in academy football showed that a substantial part of the time-loss injuries were in fact partial time-loss injuries (Veith et al., 2022). As much as 23 % of the injury burden in this particular study was caused by a partial time-loss. These findings highlight the importance of communication across medical and coaching staff, both in rehabilitation and prevention of injuries. This means that the nuances in participation and training modification also needs to be investigated among youth athletes, to find the true burden caused by injuries and illness.

Following the call for more studies investigating epidemiology and risk factors of injury in youth sports, additional studies have emerged (Steffen & Engebretsen, 2010). Studies have investigated risk factors and preventative measures aimed to reduce the prevalence of injuries among this population (Malina et al., 2006; Towlson et al., 2021). These steps are in line with the procedures that has been described in earlier years (Finch, 2006; van Mechelen et al., 1992). In order to develop and measure the effects of preventative measures in youth sports, the extent and burden of injuries and identification of potential risk factors and injury mechanisms have to be examined first (Finch, 2006; van Mechelen et al., 1992).

Growth and maturation

During adolescence, youth athletes will experience rapid changes in growth. Growth is defined as an increase in the size of the body, as a whole or the size attained by specific parts of the body (Malina et al., 2004). Growth can be measured by monitoring changes in anthropometrics, stature, body mass, leg length etc. Importantly, growth is not a linear process but contains phases of slower and faster growth (Malina et al., 2004).

During the growth process, adolescent boys and girls experience a phase of rapid growth that on average takes off between the age of 8 to 10 in girls, and 10 to 12 in boys (Malina et al., 2004). This is the start of the adolescent growth spurt, where the period in which they experience the highest rate of growth is described as their peak height velocity (PHV) (Malina et al., 2004). In average, this occurs between the age of 11 to 12 and 13 to 14 in girls and boys, respectively. During PHV, the average growth rates are reported to be between 7 to 9 cm per year in girls, and 8 to 10 cm per year in boys (Malina et al., 2004).

During the adolescent growth spurt, not only the height changes, but also body composition. The legs tend to grow before the trunk, and increase in height is observed before increase in weight (Beunen et al., 2006; Kvist et al., 2021). The period in which adolescent boys and girls experience the fastest increase in weight is called peak weight velocity (PWV). This occurs on average 4 to 10 months after reaching PHV in girls, and 3 to 6 months after reaching PHV in boys. During this period, the observed increase in body mass can be between 6 to 9 kg per year and 8 to 10 kg per year in girls and boys, respectively (Malina et al., 2004).

Growth and maturation during the adolescent years contain multiple different individual courses, and great variations is observed within chronological age groups. This is even more profound around the period of PHV, were physical characteristics show large variations (Figueiredo et al., 2010; Hannon, Coleman, et al., 2021). Differences in height, body mass and fat free mass are all factors contributing to a high level of diversity within populations in similar chronological age (Figueiredo et al., 2010; D. Johnson et al., 2022).

Methods assessing growth and maturation in youth

There are various existing methods of assessing growth and maturation in youth athletes (Salter et al., 2021; Towlson et al., 2021). With multiple methods available, practitioners should be aware of the potential limitations in each method and implement reliable testing protocols to increase the usefulness and accuracy of data (Towlson et al., 2021).

One common method used to assess maturity in youth sports is skeletal age (Malina et al., 2012; Salter et al., 2022). This method requires a hand-wrist radiograph, and specific training and expertise for implementation and evaluation. Radiographs are often evaluated using the Fels method for assessing skeletal maturity (Chumela et al., 1989). When estimating skeletal age, a radiograph of the left wrist is used to compare an individual´s bone and indicators of skeletal maturity with reference data (Fransen et al., 2018). Despite being a common and precise method, it can be an impractical solution in some sporting environments.

Due to practicality and potential influence of physical and psychological risk factors related to more "invasive" assessments, other indicators of maturity status have been introduced and included in studies of young athletes (Malina et al., 2012). The indicators, often labelled as "non-invasive", use anthropometric measures in combination with other parameters such as chronological age and height of biological parents to assess each individuals maturity status (Fransen et al., 2018; Malina et al., 2012; Salter et al., 2022). The non-invasive methods offer an indication of the individuals biological age and estimate both the timing and tempo of maturation (Fransen et al., 2018; Khamis & Roche, 1994; Malina & Kozieł, 2014a, 2014b; Mirwald et al., 2002; Moore et al., 2015). These maturity estimations are now frequently used in combination with longitudinal growth data, to further inform decisions regarding the young athlete´s development (D. M. Johnson et al., 2022; Monasterio et al., 2021; Salter et al., 2021; van der Sluis et al., 2015).

However, the use of somatic equations has over time received criticism for their lack of validity (Lolli et al., 2022; Malina & Kozieł, 2014a; Mills et al., 2017; Nevill & Burton, 2018; Teunissen et al., 2020). The maturity offset method has been showed to potentially overestimate or underestimate the timing of PHV in older and younger age groups respectively, as well as increasing errors in estimating the maturity of early- and late maturing males (Malina & Kozieł, 2014a; Mills et al., 2017). In later years, the Khamis-Roche method has been used more frequently, as an alternative to the maturity offset method (Khamis & Roche, 1994; Salter et al., 2021). The Khamis-Roche method is a predication method which requires chronological age, height, weight and mid-parent height (Khamis & Roche, 1994). This equation includes age- and sex-specific constants for height, weight, and mid-parent height, and indicates the maturity status through expressing the individual´s current height as a percentage of their predicted adult height. The Khamis-Roche prediction method reportedly predicts the adult stature to within 2.8 and 7.2cm when applied to individuals within the ages of where the adolescent growth spurt occurs (Khamis & Roche, 1994; Salter et al., 2022). In general, methods for predicting height have previously been criticised for not having the ability to predict the timing or intensity of the adolescent growth spurt (Malina et al., 2019; Preece, 1988). The use of percentage of adult height to indicate maturity status has recently been reported as an inconsistent statistic for determining the extent of completed growth, which potentially can bias the decision-making for practitioners and researches using this method (Lolli et al., 2022). In a group of male academy football players, Lolli et al. (2022) found that the percentage of mature height was biased too low for the players with shorter adult height, and biased too high for the players with higher adult height (Lolli et al., 2022). Towlson et al. (2021) stated in their review that the errors associated with the equations for estimating maturity should be considered together with the errors associated with other anthropometric measures, for instance the self-reported birth-parent height (Towlson et al., 2021). In addition, practitioners should be aware of their limitations and implement reliable testing protocols to increase the usefulness and accuracy of data (Towlson et al., 2021).

Growth and maturation as potential risk factors in youth sports

Among other potential risk factors for injuries in youth athletes, factors related to pubertal growth and maturation in adolescence have received increasing attention over the last decades (D. M. Johnson et al., 2022; Le Gall et al., 2007; van der Sluis et al., 2014). A systematic review published in 2018 stated that it is plausible that maturation, growth and musculoskeletal conditions in young athletes are factors that can influence each other, and that the association between biological maturation or growth and musculoskeletal conditions should be investigated further (Swain et al., 2018). These authors also stated that while the association remains plausible, large proportions of the knowledge presented until 2018 was at a high risk of bias, and that growth and maturation therefore should remain to be supported as independent risk factors for injury.

Most of the previous studies investigating the relationship between growth, maturation and injury in youth athletes have been done in an academy football setting, using different methods to both estimate maturity and to define injury. One of the first and most comprehensive studies was conducted by Le Gall et al. (2007), using data collected from 233 male academy football players to investigate the relationship between skeletal maturation and injury (Le Gall et al., 2007). Injuries were in this study defined as an injury received during training or competition preventing a player for full participation for more than 48 hours. Interestingly, they observed a higher incidence of tendinopathies, groin strains and re-injuries in the early maturing players, a higher incidence of tendinopathies and osteochondral disorders in normal-maturing players, and higher incidence of osteochondral disorders as well as major injuries in the late-maturing players (Le Gall et al., 2007). There were no significant differences on overall injury incidence, and seasonal disposition between early-, normal- or late-maturing players (Le Gall et al., 2007). Also, they suggested that late- and early maturing players seemed to be more vulnerable to different injuries, compared to players maturing on time.

Van der Sluis et al. (2014, 2015) followed 26 Dutch football players for three years, and investigated the importance of PHV and timing of PHV using the maturity offset method

(Mirwald et al., 2002; van der Sluis et al., 2014, 2015). They found that athletes had significantly more traumatic injuries in the year of PHV, compared to the year before PHV (van der Sluis et al., 2014). In addition, later maturing players had a significantly higher overuse injury incidence, than their earlier maturing counterparts both the year before PHV and the year of PHV (van der Sluis et al., 2015). The authors also stated that players appeared to be especially susceptible to injury between the age of 13.5 to 14.5. Another study, also including male Dutch academy football players in the U12 to U19 age groups, found that players were more prone to injuries during the six months after PHV. Also, the U15, U16 and U17 age groups showed a higher injury burden compared to other age groups included. In an English study, where 76 male academy football players were analysed over two full competitive seasons (D. Johnson et al., 2019), they found that the period of cirka-PHV was associated with a higher incidence rate compared with the period of pre-PHV. However, the higher incidence of injury in the cirka-PHV period was not dependent on the maturity timing of the individuals. In contrast with the Dutch studies (Bult et al., 2018; van der Sluis et al., 2014, 2015), the participants' somatic maturation was estimated by using their current height as a percent of their predicted adult height (POAH) (D. Johnson et al., 2019; Khamis & Roche, 1994). In Johnson et al. (2022) they investigated the influence of exposure, growth and maturation on injury risk further in 49 male youth footballers (D. M. Johnson et al., 2022). They found a non-linear relationship between percent of predicted adult height, and both injury incidence and burden, with the highest risk and burden occurring at 92 % and 95 % of predicted adult height, respectively. The highest likelihood of injury occurred at 92 % of predicted adult height, and the likelihood of injury increased together with an increase in POAH between 83 % and 93 %. This transfers to the period of an individual entering PHV(D. M. Johnson et al., 2022) .

To investigate possible anthropometric injury risk factors, 101 Dutch male elite youth football players between 11 and 19 years of age were monitored with monthly anthropometric measurements (Kemper et al., 2015). Growth equal to or more than 0.6cm per month was identified as a risk factor for injury (Kemper et al., 2015). This transfers to a growth rate equal to or more than 7.2cm per year. In the previously mentioned study on English academy football players who found a linear relationship between growth rate and injury incidence, they also identified a linear relationship between lower-limb growth and injury incidence (D. M. Johnson et al., 2022). In addition, players with a growth rate above 7.2cm per year, was estimated to have a 74 % higher likelihood for injury. These players were found to be injured than the players growing less than 7.2cm per year. Another study including 314 male youth football players found relative age, body weight, leg length, total growth and leg length growth to be associated with increased injury risk in both younger (U10-U12) and older (U13-U15) age groups (Rommers et al., 2020).

In Qatar, at the ASPETAR Academy, the research group led by Materne et al. (2021) investigated the association of skeletal maturity and injury risk (Materne et al., 2021a). In a cohort of 283 academy football players in the U13 to U19 age groups, the early maturing players showed a significantly greater risk of injury versus normal and mature players. They were also found to have the greatest overall adjusted injury risk. The injury patterns and injury risk varied depending on the players maturity status, but players who were already skeletally mature had the lowest risk of lower extremity apophyseal injuries.

Using data from 110 Spanish male academy football players over the course of twenty consecutive seasons, combined with full growth curves for each individual, Monasterio and his research group investigated the burden of injuries according to maturity status and timing (Monasterio et al., 2021). Before PHV, growth-related and knee joint/ligament injuries had a lower burden in players who matured late, compared to those who matured on time. Players who were more than six months post-PHV and registered a growth velocity of less than 1 cm per year were defined as adults until they left the academy. The adult late maturers showed a greater burden of overall and joint/ligament injuries, compared to early maturing players. Injury burden was significantly lower in players pre-PHV, compared to players cirka- and post-PHV. Growth related injuries had a greater injury burden cirka-PHV, while muscle and joint/ligament injuries were more burdensome post-PHV, especially in adults. The researchers concluded that football academies should regularly assess the maturity status and timing of young football players, as the impact of injuries varies with maturation status and timing (Monasterio et al., 2021).

Somewhat similar findings to the data observed in football have also been showed in athletics and alpine skiing (Schoeb et al., 2020; Wik et al., 2020). When investigating injuries in young track and field athletes Wik et al. (2020) found that overall growth rate and leg length growth were associated with greater overall injury risk, as well as greater risk of bone and growth plate injuries (Wik et al., 2020). They also found that more mature athletes had less likelihood of experiencing these growth plate injuries. Using the maturity offset method in a group of

155 youth alpine skiers, Schoeb et al. (2020) observed a direct association between the offset to the age at PHV and the occurrence and severity of acute injuries (Schoeb et al., 2020).

Study purpose

Hence, due to the less explored details surrounding health problems and factors related to pubertal growth in youth athletes in Norway, the present project aims to investigate the possible relationship between self-reported health problems and growth and maturation in Norwegian youth athletes. Furthermore, the present project will contribute to more knowledge on the prevalence and burden of injury and illness among youth athletes. In contrast to other studies, this study includes athletes of both genders, and from both team- and individual sports. This is aimed to bring a broader view into the relationship between growth, maturation, and health problems, as well as the challenges seen in preventing injury and illness in the young athletic population. To our knowledge, there has not been conducted any studies of similar extent investigating the injury prevalence and potential risk factors related to growth and maturation among Norwegian youth athletes. Recent reports suggest approximately 76 % of the Norwegian boys and girls between the age of 9 and 15 years participate in some form of organised sporting activity (*3 av 4 barn deltar i organisert idrett på fritiden*, n.d.). Also, in Norway there are fifteen or more Sports Specialised Secondary Schools for 12- to 16-year-old athletes in different sports, offering an important role in education and development of the country´s next generation of athletes and citizens. Cooperation with these schools is therefore important, as it might provide the schools with a greater insight in how to improve their role, and to aid the implementation of injury prevention and talent development.

1.0 INTRODUCTION

To reach their full potential in athletic development it should be a priority for youth athletes to fully participate in their sport and avoid injuries which can result in a significant loss in both training and competition (Bergeron et al., 2015; Ward et al., 2007). Injuries at youth level can make young athletes more susceptible to future injuries and long-term health risks when becoming adults (Maffulli et al., 2010). Previous studies investigating the weekly prevalence of injuries among youth athletes competing in various sports have been found to vary between 25 to 65 %, and a weekly prevalence of substantial health problems causing changes in participation between 16 and 25 % (Dalen-Lorentsen et al., 2021; Moseid et al., 2018; Nordstrøm et al., 2021; Schoeb et al., 2020). Also, data suggests that injuries in youth sports often lead to partial time-loss(Veith et al., 2022). To find the true burden from injury and illness the nuances in participation and training modification should be better investigated among youth athletes.

Among other potential risk factors for injuries in youth athletes, factors related to pubertal growth and maturation in adolescence have received increasing attention over the last decades (D. M. Johnson et al., 2022; Le Gall et al., 2007; van der Sluis et al., 2014). At the same time, while the association between growth, maturation, and injuries remain plausible, large proportions of the knowledge presented up until 2018 was at a high risk of bias, and that growth and maturation therefore should remain to be supported as independent risk factors of injury (Swain et al., 2018). With multiple methods available to monitor growth and maturation, practitioners should be aware of the potential limitations in each method and implement reliable testing protocols to increase the usefulness and accuracy of data (Towlson et al., 2021).

Recently, differences in maturity status as well as maturity tempo has been associated with different likelihood of injury and different injury burden (D. Johnson et al., 2019; D. M. Johnson et al., 2022; Materne et al., 2021a; Monasterio et al., 2021; Wik et al., 2020). These studies also suggests higher growth- and lower limb growth rates to be associated with greater risk of injury and greater injury burden (D. M. Johnson et al., 2022; Kemper et al., 2015; Rommers et al., 2020; Wik et al., 2020). These risk factors found in relation to growth and maturation have been most profoundly investigated in youth male football, but also in sports as athletics and alpine skiing (Schoeb et al., 2020; Wik & Martinez Silvan, 2019).

1.1 Aims

To the authors knowledge, there has not been conducted any studies of similar extent investigating the injury prevalence and potential risk factors related to growth and maturation among Norwegian youth athletes. Therefore, the aims in the present study are as following:

Primarily, is there a relationship between maturity status and self-reported health problems in Norwegian youth athletes?

Secondarily, is there a relationship between growth and self-reported problems, and does growth and maturity status affect what type of injuries being reported?

A long with the primary and secondary aims, this project aims to highlight the prevalence of self-reported health problems in Norwegian youth athletes. We hypothesize the period of cirka-PHV to be related to higher prevalence and severity of self-reported health problems among Norwegian youth athletes. We also hypothesize that high growth rates are related to higher prevalence and severity of self-reported health problems. Lastly, we hypothesize the period of cirka-PHV and high growth rates to be related to more cases of overuse injuries. To delve deeper into the relationship between growth, maturation and health problems in this population, this project offers a greater insight in how Norwegian Sport Specialised Secondary Schools can work to improve their role, and to aid the implementation of injury prevention.

2.0 METHOD

2.1 Study design

The present study is a prospective observation study investigating possible relationships between growth, maturation, and health problems among Norwegian youth athletes over a 13-week period. All participants underwent anthropometric measurements before and after the study period and answered a weekly questionnaire on health problems during the study period.

2.2 Recruitment

To reach out to a large population of youth athletes in Norway, fifteen sports specialised secondary schools were contacted, informed through meetings, and invited to participate in the project. Schools accepting the invitation distributed further information and digital consent forms to the athletes and their parents. To participate in the study, parents gave consent on behalf of their children and participated in the study through reporting their own height. If necessary, participants not living with their biological parents were able to be included through the school distributing a separate consent form enabling the biological parents to report their height. Each school started their data collection after accepting the invitation, and the questionnaires were distributed to the schools following the completion of their first anthropometric measurement. Recruitment process is described in further detail in Figure 1.

All participants are athletes attending sports specialised secondary schools in Norway, where varied training and physical activity is a standard part of their everyday school. The included athletes are between 12 and 16 years of age, and therefore likely provided a sample of boys and girls before, during and after their peak height velocity (PHV) (Malina et al., 2004).

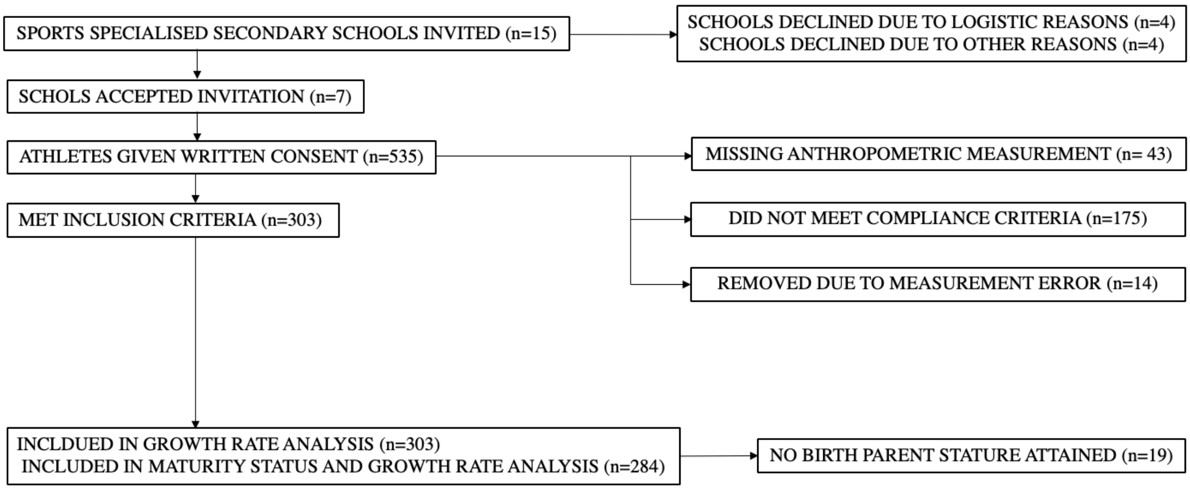

Figure 1 *-Flow chart describing the recruitment process from invitation of schools to athletes included in the final analysis.*

2.2.3 Inclusion and exclusion criteria

Athletes included in the final analysis had completed the anthropometric measurements at the two given timepoints for each school. They also had a compliance of more than 50 % on the weekly questionnaires, as well as response registered at least every other week (Clarsen et al., 2020). The athletes who did not have the height of their biological parents available, or for other reasons was not possible to calculate maturity status, were only included in the growth rate analysis.

2.2.2 Power calculation

There was no calculation for sample size done prior to the project. While sample size vary greatly in other studies who have investigated relationships between potential risk factors and injuries, Bahr and Holm (2003) suggested a number of 30-50 injured subjects should be adequate to find moderate to strong associations. They also suggested 200 injured subjects as adequate to find small to moderate associations (Bahr & Holme, 2003). Since previous studies have showed a prevalence of more than 40 % for health problems, and 20-25 % for substantial health problems, the goal then was to include more than 300 participants to this study (Dalen-Lorentsen et al., 2021; Moseid et al., 2018). With fifteen Sport Specialised Secondary Schools in Norway, with an average of approximately 90 youth athletes per school, the goal of recruiting 300 participants was deemed realistic.

2.3 Outcome measures

2.3.1 Anthropometrics

Anthropometric measures (height, sitting height and body weight) were conducted at two separate time points, at the beginning and end of the project period in each school between August 2022 and January 2023). Anthropometrics was measured following the International Society for the Advancement of Kinanthropometry (ISAK) procedures (Norton, 2018), by either an assigned person working at the school, or the master student (JM). However, the same equipment (seca213 stadiometer, seca813 scale, Hamburg, Germany) and procedures were conducted on both time points at all schools. Following the distributed protocol for data collection of all anthropometric measurements (Attachment 1) were blinded for the athletes and was conducted in an individual matter.

Height, sitting height and body weight was measured twice, using the average of the two measurements. Leg length was calculated subtracting the sitting height from the standing height for every individual. The maturity status was expressed through using their current height as a percentage of their predicted adult height (D. M. Johnson et al., 2022; Roche et al., 1983). The maturity status was calculated with the spreadsheet from Towlson et al (2021) using the Khamis-Roche method (Khamis & Roche, 1994). The height of biological parents was self-reported and collected together with the parents' consent, before being adjusted for overestimation (Epstein et al., 1995). Individuals between 88 and 95 % of predicted adult stature was categorised as being cirka-PHV. Individuals under 88 % and over 95 % were categorised as pre-PHV, and post-PHV respectively. For each individual, the maturity status used for analysis was calculated as the median percent of predicted adult height (POAH) from the anthropometric measurements collected at the two given timepoints. Growth rate was calculated following the second measurement for standing height using the growth and time between first and second measurements, expressed as growth in centimetre per year. Athletes were assigned to a group of either high growth rate (> 7.2cm/year) or low growth rate(< 7.2cm/year) (D. M. Johnson et al., 2022; Kemper et al., 2015). Athletes who for different reasons participated but were unable to use the height of their biological parents to calculate maturity status, was only included in the analysis using growth rate. Leg length and leg length growth rate was removed from the analysis, due to missing data and variations in measurements procedures between schools.

2.3.2 Health Problems

Reporting of injury and illness over the course of the project was done using the updated version of Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H2) (Clarsen et al., 2020). This is a digital questionnaire consisting of four main domains, concerning participation, training modification, performance, and symptoms. In addition, to reduce the lack of diagnostic details seen in other research investigating injury prevalence (Clarsen et al., 2020; Nielsen et al., 2019), the athletes responded to the version of the questionnaire containing recurrence, region, type of injury, and time-loss. Each athletes was able to report a maximum of two health problems on each weekly registration. The questionnaire was distributed to the athletes weekly using an online questionnaire service (https://nettskjema.no). To increase the response rate for each school, the athletes were reminded and given a 5-minute window by their teacher during school hours to fill out their individual questionnaires. This procedure was conducted at the same time every week. Athletes who reported a health problem for four or more consecutive weeks were flagged and contacted through the school with information and advice concerning possible diagnostic and treatment options through their sports federation.

The answers were analysed in Microsoft Excel (2023) and categorised as either a health problem, substantial health problem or no health problem. Health problems was defined as every self-reported injury or illness, which is in line with the injury definitions as any physical complaint (Bahr, 2009; Fuller et al., 2006; Pluim et al., 2009). Substantial health problems was defined as a self-reported injury or illness leading to moderate or severe changes in participation or performance (Clarsen et al., 2013). This also includes health problems leading to a full time-loss. Each answer was also given a severity score between 0 and 25, were 0 represented no complaints and 25 represented the highest possible complaint for each domain. Values from each answer were used to calculate a severity score from 0 to 100 for each reported health problem. The cumulative severity score was calculated for both all health problems and substantial health problems. Number of health problems was defined as every new health problem reported during the data collection period. Prevalence for both health problems and substantial health problems was calculated as the percentage of the total answers reported, containing a health problem or substantial health problem. Full time-loss was defined and calculated as the total number of sessions not participated in. Partial time-loss was defined and calculated as the total number of sessions with reduced participation, while total time-loss was the defined as the full and partial time-loss combined. Type of health problem was through the questionnaire defined as either an acute injury, overuse injury or illness. A separate injury variable was also added and was calculated as the sum of all acute and overuse injuries.

Athletes with a lower response rate than 50 %, or athletes who had more than two weeks between responses to the questionnaire were excluded from the study. At the first week of the data collection, a separate questionnaire was distributed to the athletess, with questions regarding age (to the closest 0.5) and type of sport they were participating. Athletes participating in multiple sports, were asked to choose their main attended sport.

2.4 Statistical Analysis

Prior to statistical analysis, all data collected from anthropometric measurements and from the OSTRC-H2 were sorted and analysed using Microsoft Excel (2023). All statistical analysis was conducted using RStudio (2023). Packages ggplot (v3.4.1), dplyr (v1.1.0), ggpubr (v0.6.0) tidyverse (v2.0.0) and tidyr (v1.3.0) was used for data preparation and visualisation. Descriptive statistics are presented as means with standard deviation (SD). To assess normal distribution of the data the Shapiro-Wilk test was used. The lme4 package (v1.1.33) was employed to investigate relationships between maturity status and health problems, as well as growth rate and health problems. This allowed to account for Poisson distribution of the dependent variables, while the emmeans package (v1.8.5) was used to compare the estimated marginal means of main outcomes between the groups of different genders, sports, maturity status and growth rates. Rate ratios (RR) were presented per unit change of the variable in in question. The modelbased package (v.0.8.6) was used to summarise non-linear models and identify the regions where the dependent variables were of highest value. Level of confidence intervals (CI) of 95 % was used, and statistical significance was set at 0.05.

2.5 Ethics

The project was reviewed and approved by South-East Norwegian Regional Ethics Committee in May 2022 (2022/469838). All participating athletes signed a written consent statement before entering the study. Everyone received information letters and consent forms by email or physically distributed in school (Attachment 2-4), including information about the aims and procedures, as well as information that they at any given time were able to withdraw from the study without further questions. The procedures followed the World Medical

Association Declaration of Helsinki. Collected data was stored and processed de-identified. Data was stored temporary in the access regulated server EduCloud, and frequently during the data collection it was transferred to Services for Sensitive Data (TSD) for storage.

The study was funded by Inland Norway University of Applied Sciences. The study members declared no conflicts of interest.

3.0 RESULTS

3.1 Participants and study period

In total 303 athletes met the inclusion criteria to be included in the project, out of which 185 were boys and 118 were girls. Descriptive statistics of the athletes are presented in Table 1. Weekly compliance is presented in Figure 2; the average compliance of the weekly questionnaire on health problems was 73 %. Athletes were grouped in to three different groups based on their maturity status, and in two different groups based on their growth rate (Table 2).

Table 1 *- Descriptive statistics presented as means with standard deviation (SD), grouped by gender and sport. Boys were taller and had higher growth rates than girls. Girls had higher maturity status. (*p < 0.05).*

Gender	Sport	n	Stature cm (SD)	Bodyweight kg (SD)	POAH % (SD)	cm/year (SD)
Boys			168.4 (9.0)*	55.5 (9.9)	92.6 (3.5)	6.4 (3.4)*
	Individual	58	167.3 (8.8)	54.5 (10.3)	92.6 (3.6)	7.0 (3.6)
	Team Sport	127	168.9 (9.1)	56.0 (9.7)	92.7 (3.5)	6.1 (3.4)
Girls			164.1 (6.4)	54.5 (7.5)	97.8 (1.3)*	3.2 (2.4)
	Individual	48	163.1 (6.2)	54.1 (6.5)	97.8 (1.1)	2.9 (2.2)
	Team Sport	70	164.8 (6.6)	54.8 (8.2)	97.7 (1.4)	3.5 (2.5)

POAH; Percent of adult height, cm/year; Growth rate in centimetre per year

In the present study the boys participating were less mature ($p < 0.001$), but taller than the girls ($p < 0.001$). There was no difference in body mass between genders. On average the maturity status was 92.6 % and 97.85 % POAH among boys and girls, respectively. The boys showed a higher average growth rate (6.4 cm/year, $p < 0.001$) compared to girls (3.2 cm/year). The time difference between the first and second anthropometric measurements among the schools ranged from 82 days to 146 days, with an average of 97 days. The seven different schools participating had their own separate periods of data collection through OSTRC-H2, which due to different logistical reasons had different durations. The periods ranged from 10 to 15 weeks, with 13 weeks as average.

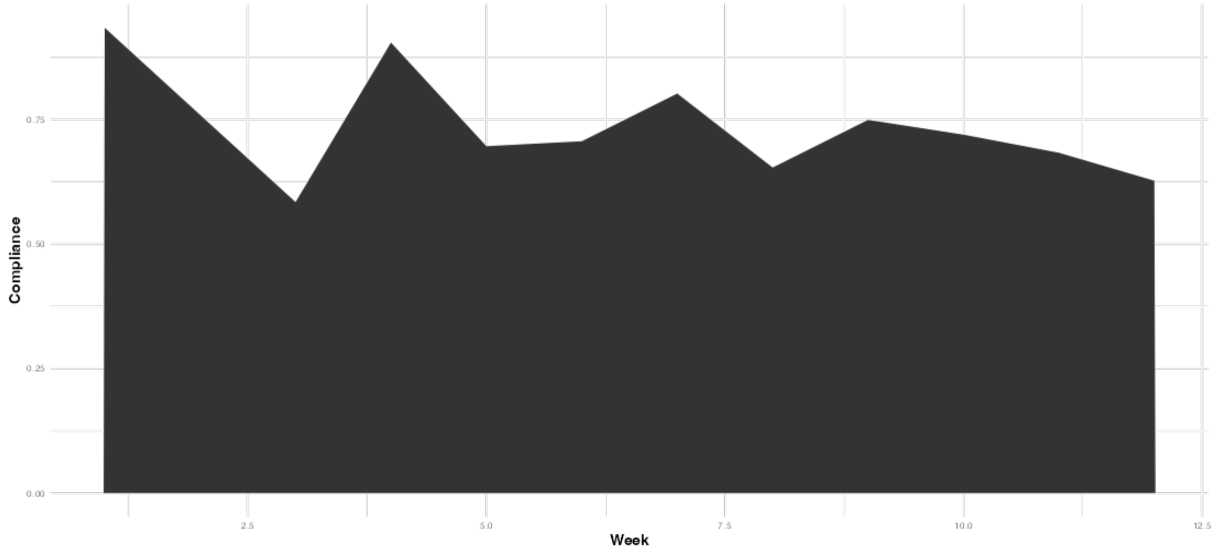

Figure 2 *- Mean weekly compliance of OSTRC-H2 (Oslo Sports Trauma Research Center Questionnaire on Health Problems) from all athletes included in final analysis.*

Table 2 *- Distribution of groups in different maturity status and growth rate, combined and by gender.*

	Pre-PHV	Cirka-PHV	Post-PHV	High growth	Low growth
All (n)	17	106	159	87	216
Boys (n)	17	102	54	77	108
Girls (n)	0	4	106	10	108

PHV; Peak Heigh Velocity, High growth; > 7.2 cm/year, Low growth; < 7.2 cm/year

3.2 Maturity status and self-reported health problems

3.2.1 Youth male athletes

No relationships between maturity status in boys and prevalence of all health problems was uncovered, nor any relationship with prevalence of substantial health problems. A non-linear relationship was found between maturity status and cumulative severity score in boys ($p < 0.001$; Figure 3). The peak estimated severity score was observed between 86.8 and 90.3 % POAH. When comparing groups of different maturity status, the severity scores were 22.9 % and 9.5 % higher in the pre-PHV group compared to the post-PHV and cirka-PHV group respectively ($p < .0001$; Figure 4). The boys cirka-PHV had higher cumulative severity score than the boys post-PHV, with a 12.2 % higher severity score ($p < 0.001$).

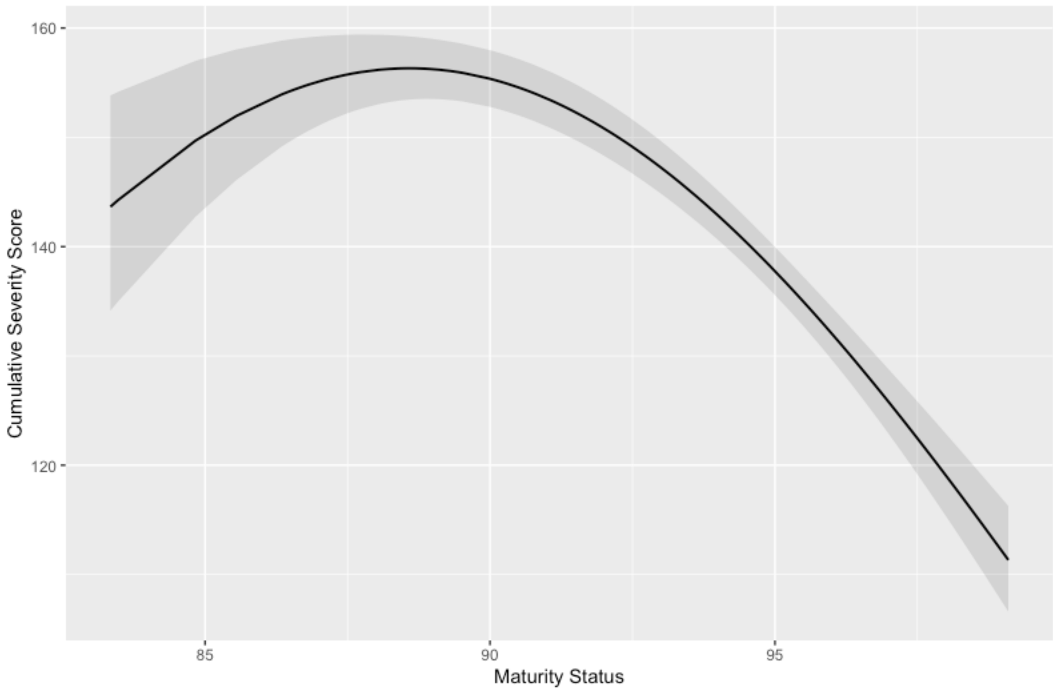

Figure 3 *- Non-linear relationship between maturity status (%) and cumulative severity score in boys (p < 0.001). Peak estimated severity score was observed between 86.8 and 90.3 % POAH (Percent of adult height). The shaded area represents the 95 % confidence interval.*

The same observations were done between maturity status and cumulative severity scores of substantial health problems, where a non-linear relationship was discovered ($p < 0.001$). Peak estimated cumulative severity score of substantial health problems was observed between 88.6 and 92 % POAH. At the same time, there was 28.8 % higher cumulative severity scores of substantial health problems in the boys pre-PHV compared to the boys post-PHV ($p < 0.0001$) and 20.7 % higher compared to the boys cirka-PHV ($p < 0.001$). Boys cirka-PHV had a 6.8 % higher severity score compared to boys post-PHV ($p = 0.0005$)

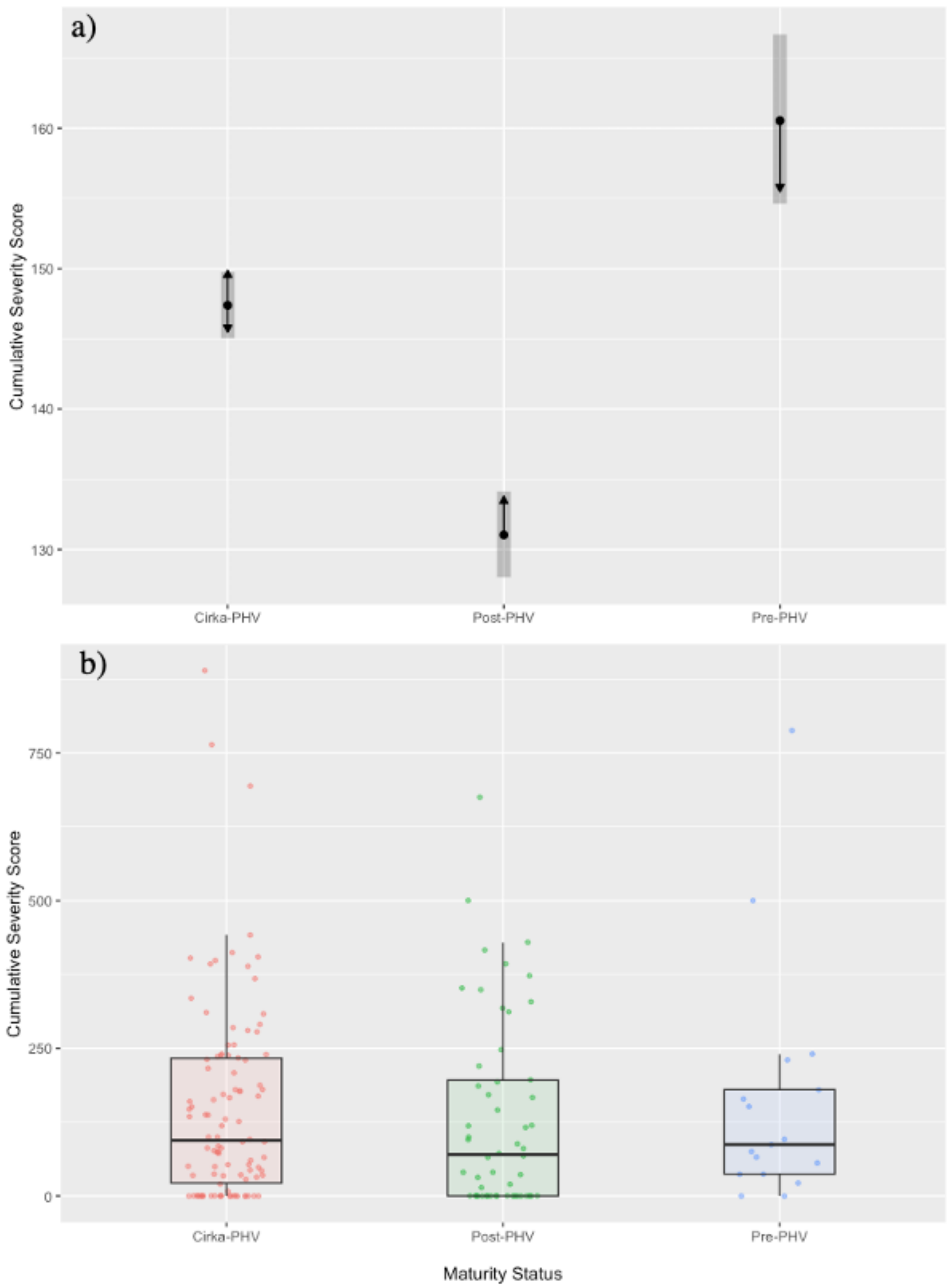

Figure 4a *- Cumulative severity score for each athlete compared between groups of different maturity status in boys. Black point represents mean estimate, shaded area represents 95 % confidence interval. Arrows allow for pairwise comparison between groups. (PHV; Peak Height Velocity).* ***Figure 4b*** *- Comparison of mean cumulative severity score between the three groups of different maturity status in boys. Higher scores were observed in the pre-PHV (pre-Peak Height Velocity) group compared to the post-PHV and cirka-PHV group (p < .0001). The boys cirka-PHV had higher cumulative severity score than the boys post-PHV (p < 0.001). One point represents one athlete.*

A non-linear relationship was observed between maturity status and duration of health problems in boys (p = 0.003; Figure 5). Peak estimated duration of health problems was observed between 86.8 and 90.3 % POAH. Boys pre-PHV reported health problems with an average of 2.1 and 2.7 days longer duration compared to boys cirka-PHV (p = 0.0101) and post-PHV respectively (p = 0.0013; Figure 6).

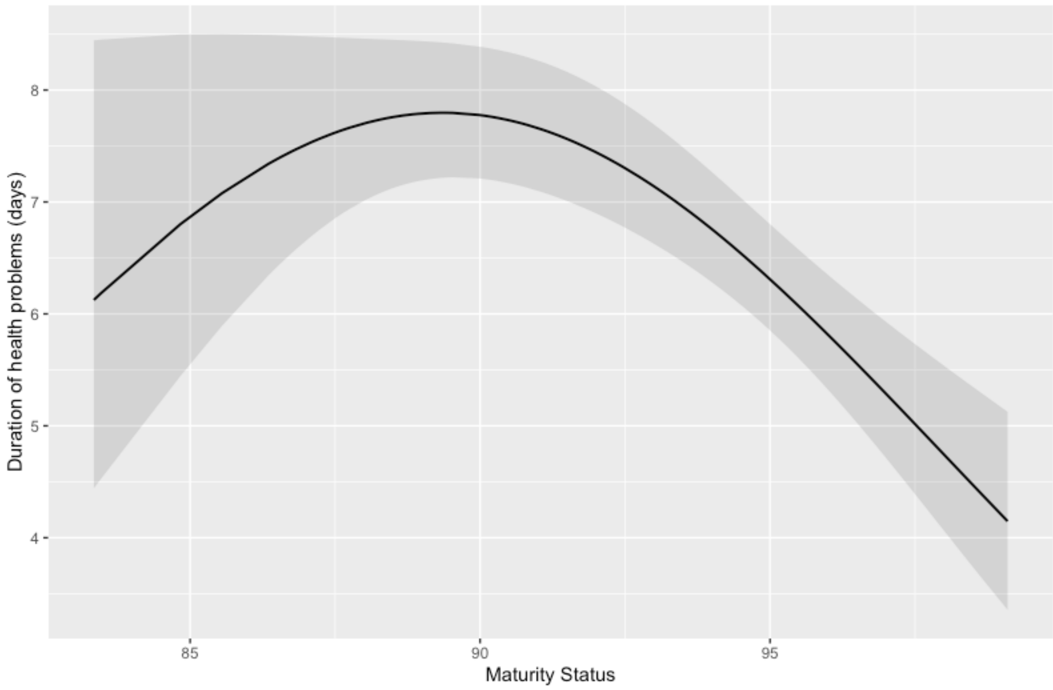

Figure 5 *- Non-linear relationship between maturity status (%) and duration of health problems in boys (p = 0.003). Peak estimated duration was observed between 86.8 and 90.3 % POAH (Percent of Adult Height). The shaded area represents the 95 % confidence intervals.*

Lastly, a non-linear relationship was found between full time-loss reported and maturity status (p = 0.001). Peak estimated full time-loss was observed between 88.6 and 92.1 % POAH. A non-linear relationship between maturity status and total time-loss in boys was also found (p = 0.001). Peak estimated total time-loss was observed between 88.6 and 92.1 %. There were no differences between the three maturity groups upon time-loss.

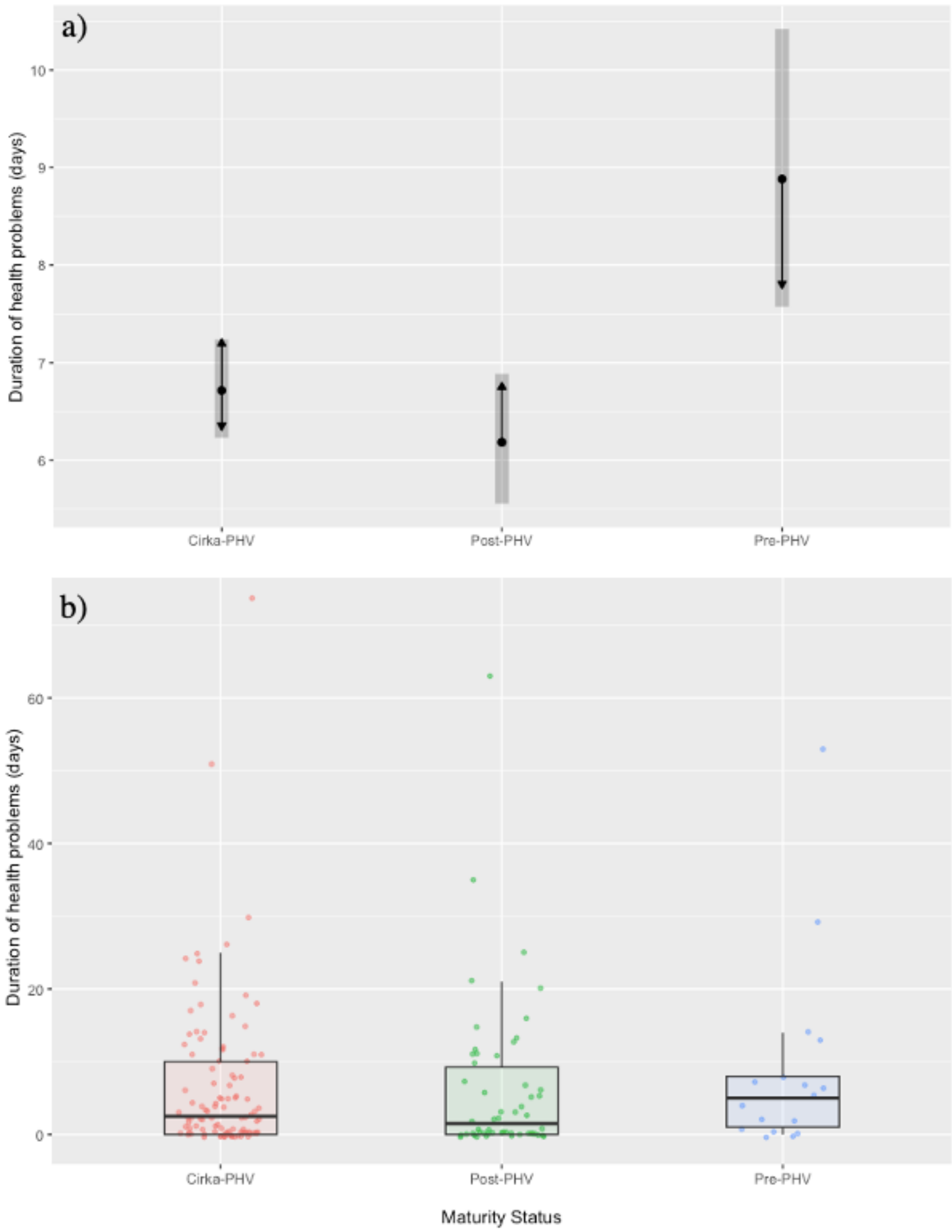

Figure 6a *- Duration of health problems compared between the three groups of different maturity status in boys. Black point represents mean estimate, shaded area represents 95 % confidence interval. Arrows allow for pairwise comparison between groups. (PHV; Peak Height Velocity).* ***Figure 6b*** *- Comparison of mean duration of health problems between the three groups of different maturity status in boys.* Boys *pre-PHV (pre-Peak Height Velocity) reported longer duration of health problems compared to boys cirka-PHV (p = 0.0101) and post-PHV (p = 0.0013). One point represents one athlete.*

3.2.2 Youth female athletes

There was not found a relationship between maturity status and prevalence of all health problems or prevalence of substantial health problems in girls. On the other hand, a non-linear relationship between cumulative severity score and maturity status was uncovered ($p < 0.001$). Peak estimated cumulative severity score among girls was observed above 99.2 % POAH. The girls post-PHV showed a 91 % higher cumulative severity score than the girls cirka-PHV ($p < 0.001$).

Similarly, a non-linear relationship between cumulative severity score of substantial health problems and maturity status in girls was found ($p < 0.001$). Peak estimated cumulative severity score of substantial health problems was observed above 99.2 % POAH. Severity score of substantial health problems was more than 3.5 times higher (149 AU vs 41.5 AU) in the girls post-PHV compared to the girls cirka-PHV ($p < 0.001$). There was no relationship between maturity status and number of new health problems reported in girls.

Between maturity status and duration of health problems and there was found a non-linear relationship ($p < 0.001$; Figure 7). Peak estimated duration of health problems was observed between 98.6 and 99.9 % POAH. The group post-PHV reported duration of their health problems to be 5.2 days longer, compared to the girls cirka-PHV ($p = 0.0021$). When investigating maturity status and time-loss in girls, there was found non-linear relationship between maturity status and full time-loss in girls ($p < 0.001$). Peak estimated full time-loss was observed between 97.8 and 99.2 %. No difference in full time-loss or partial time-loss was observed between the groups of different maturity status. Group differences were prevalent when investigating total time-loss, where the group post-PHV showed a higher total time-loss than the cirka-PHV group ($p = 0.0043$). The girls post-PHV reported on average 4.7 days more with reduced or no participation. A non-linear relationship was uncovered between total time-loss and maturity status in girls ($p < 0.001$). Peak estimated total time-loss was observed between 98.6 and 99.9 % POAH.

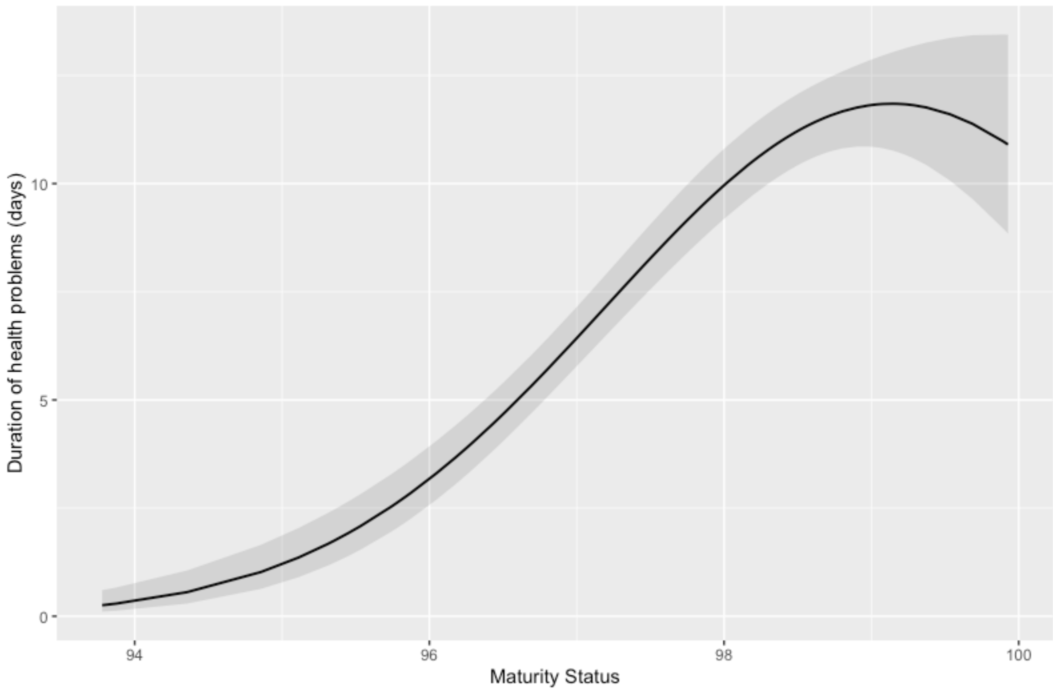

Figure 7 *- Non-linear relationship between maturity status and duration of health problems in girls (p < 0.001). Peak estimated duration was observed between 98.6. and 99.9 % POAH (Percent of Adult Height). The shaded area represents the 95 % confidence intervals.*

3.3 Growth rate and self-reported health problems

3.3.1 Youth male athletes

No relationship between growth rate and prevalence of all health problems or prevalence of substantial health problems was discovered among the boys. In boys, a linear relationship was found between growth rate and cumulative severity score (RR: 1.05, 95 % CI 1.05-1.06, $p < 0.001$; Figure 8). When comparing groups, boys with a high growth rate (> 7.2cm/year) had 52.6 % higher cumulative severity scores compared to the boys with low growth rates (< 7.2cm/year) ($p < 0.001$; Figure 9)

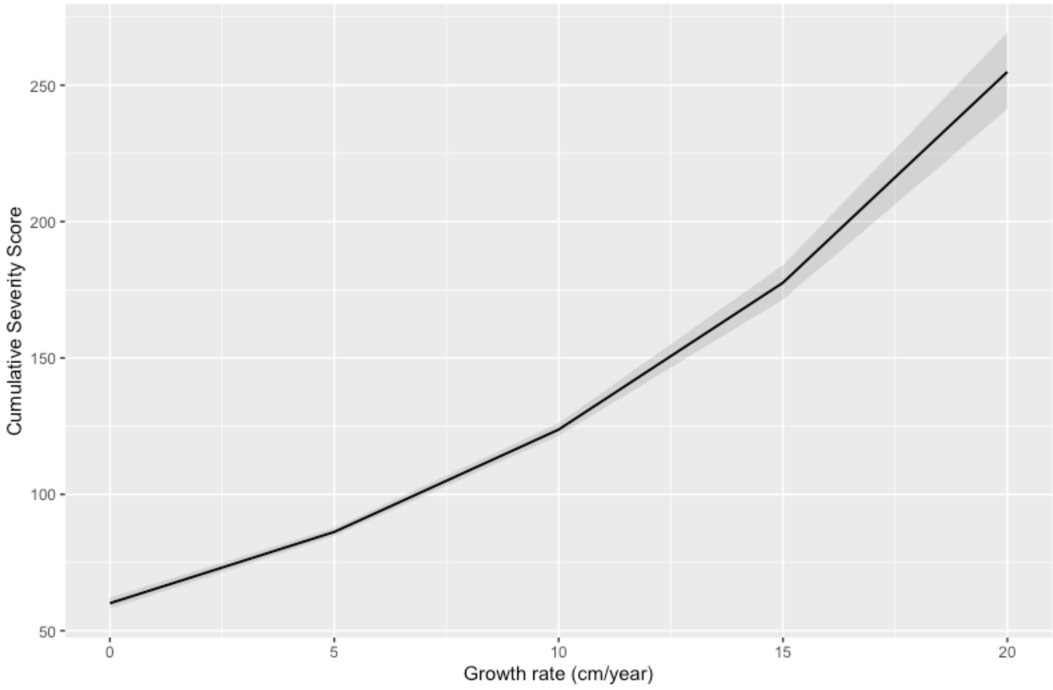

Figure 8 - *Linear relationship between growth rate and cumulative severity score in boys (RR 1.05, 95 %CI 1.05-1.06, p < 0.001. The shaded area represents the 95 % confidence intervals. (RR; Rate ratio, CI; Confidence interval) cm/year; centimeter per year)*

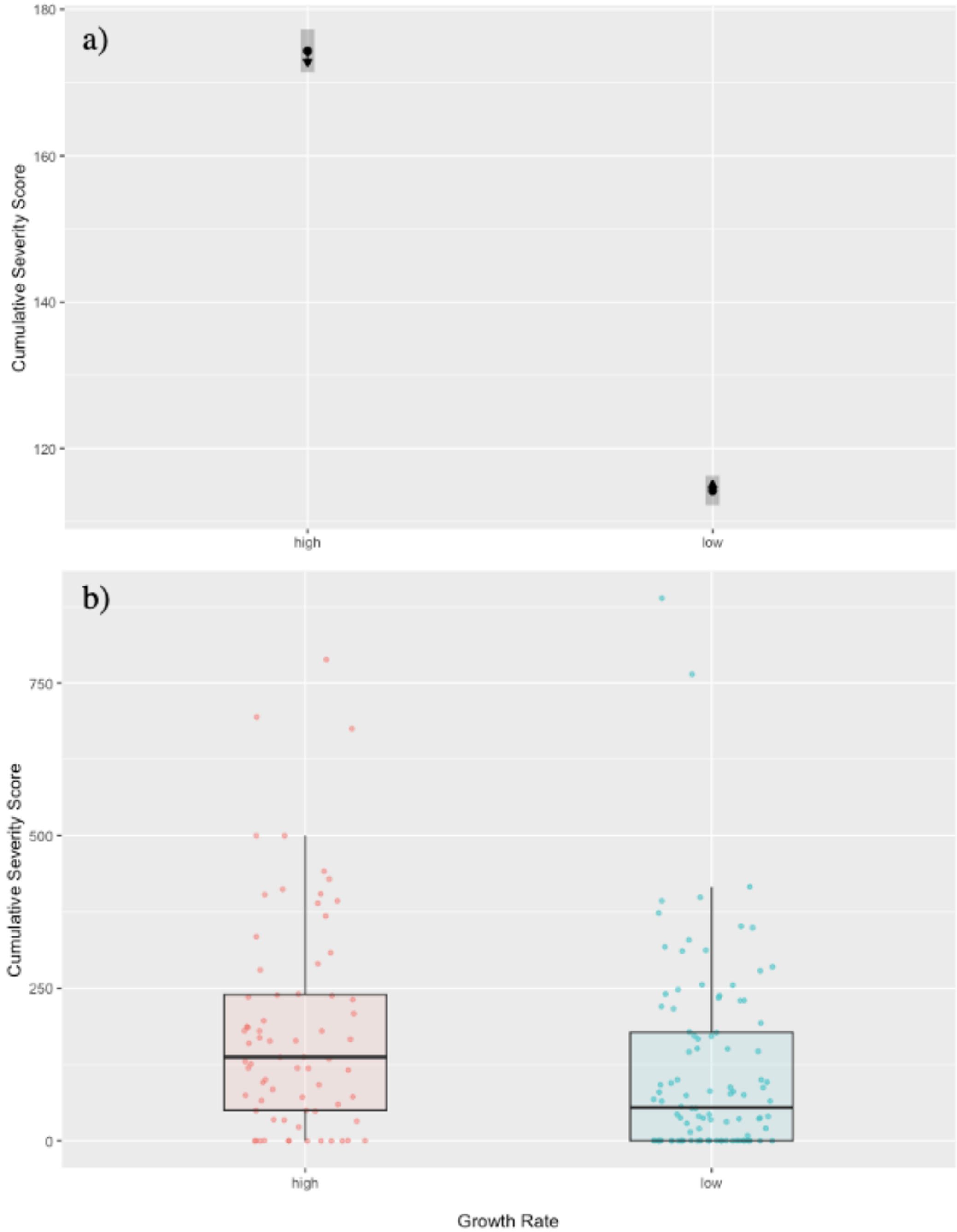

Figure 9a *- Comparison of mean cumulative severity score between the groups of high (>7.2cm/year) and low (<7.2cm/year) growth rates in boys. Black point represents mean estimate, shaded area represents 95 % confidence interval. Arrows allow for pairwise comparison between groups.* ***Figure 9b*** *- Comparison of mean cumulative severity score between the groups of high (>7.2cm/year) and low (<7.2cm/year) growth rates in boys. Boys with high growth rates had higher severity scores compared to boys with low growth rates ($p < 0.001$). One point represents one athlete.*

In cumulative severity score of substantial health problems, there was a linear relationship with growth rate (RR: 1.07, 95 % CI 1.07-1.08, $p < 0.001$). Boys with high growth rate had reported 74.5 % higher cumulative severity score of substantial health problems compared to boys with lower growth rates ($p < 0.001$). There was no relationship between growth rate and number of new health problems reported.

When investigating duration of health problems in boys, a linear relationship was found with growth rate (RR: 1.09, 95 % CI 1.08-1.11, $p < 0.001$). The group with higher growth rates had health problems reported to last on average 4.4 days longer compared to the group with lower growth rates ($p < 0.001$).

In boys, growth rate was related to full time-loss in a linear relationship (RR: 1.14, 95 % CI 1.11-1.17, $p < 0.001$). A linear relationship was also observed with partial time-loss (RR: 1.06, 95 % CI 1.03 -1.08, $p < 0.001$) and total time-loss (RR: 1.10, 95 % CI 1.08 – 1.12, $p < 0.0001$). Between the groups of high and low growth rates there was an average difference of 3.7 more days of reduced participation or no participation, with the boys with high growth rate losing the most days. They reported a higher full time-loss ($p < 0.001$), partial time-loss ($p = 0.0002$) and total time-loss ($p < 0.0001$) compared to the group with low growth rate.

3.3.2 Youth Female Athletes

In girls no relationship was found with growth rate and prevalence of all health problems or prevalence of substantial health problems.

A non-linear relationship between growth rate and cumulative severity score was found ($p < 0.001$; Figure 10). Peak estimated cumulative severity score was observed in growth rates lower than 1.7 cm/year and higher than 8.5 cm/year. The group of girls with high growth rates, had an average of 6.5 % higher severity score compared to the girls with low growth rates ($p < 0.0001$; Figure 11)

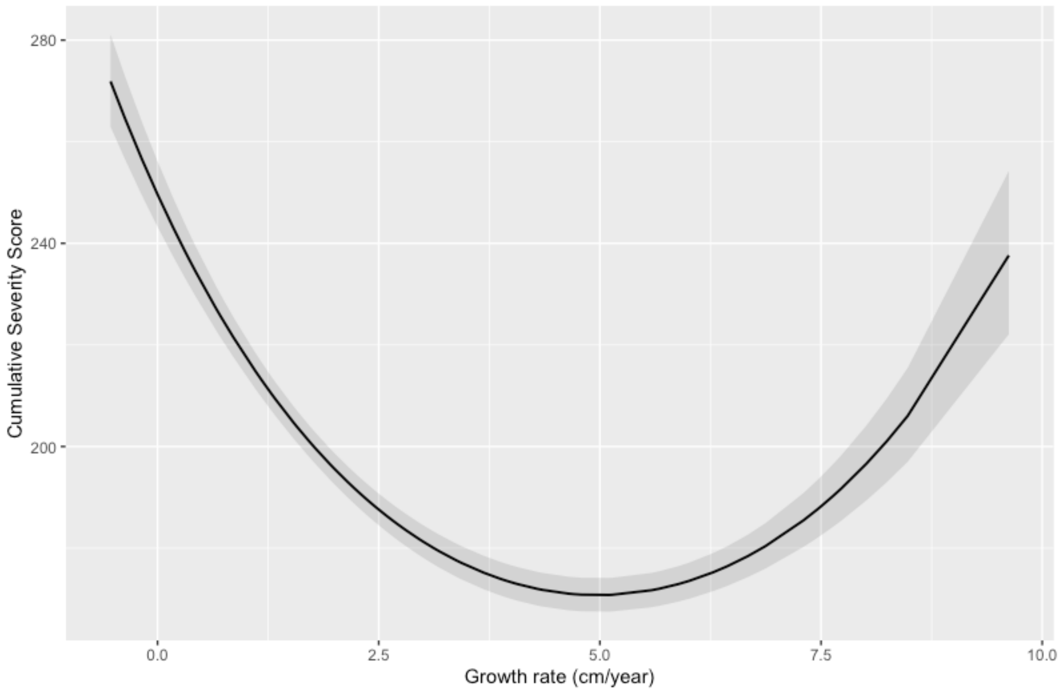

Figure 10 *- Non-linear relationship between growth rate and cumulative severity score in girls ($p < 0.001$). Peak estimated duration was observed lower than 1.7cm/year and higher than 8.5cm/year. The shaded area represents the 95 % confidence intervals.*

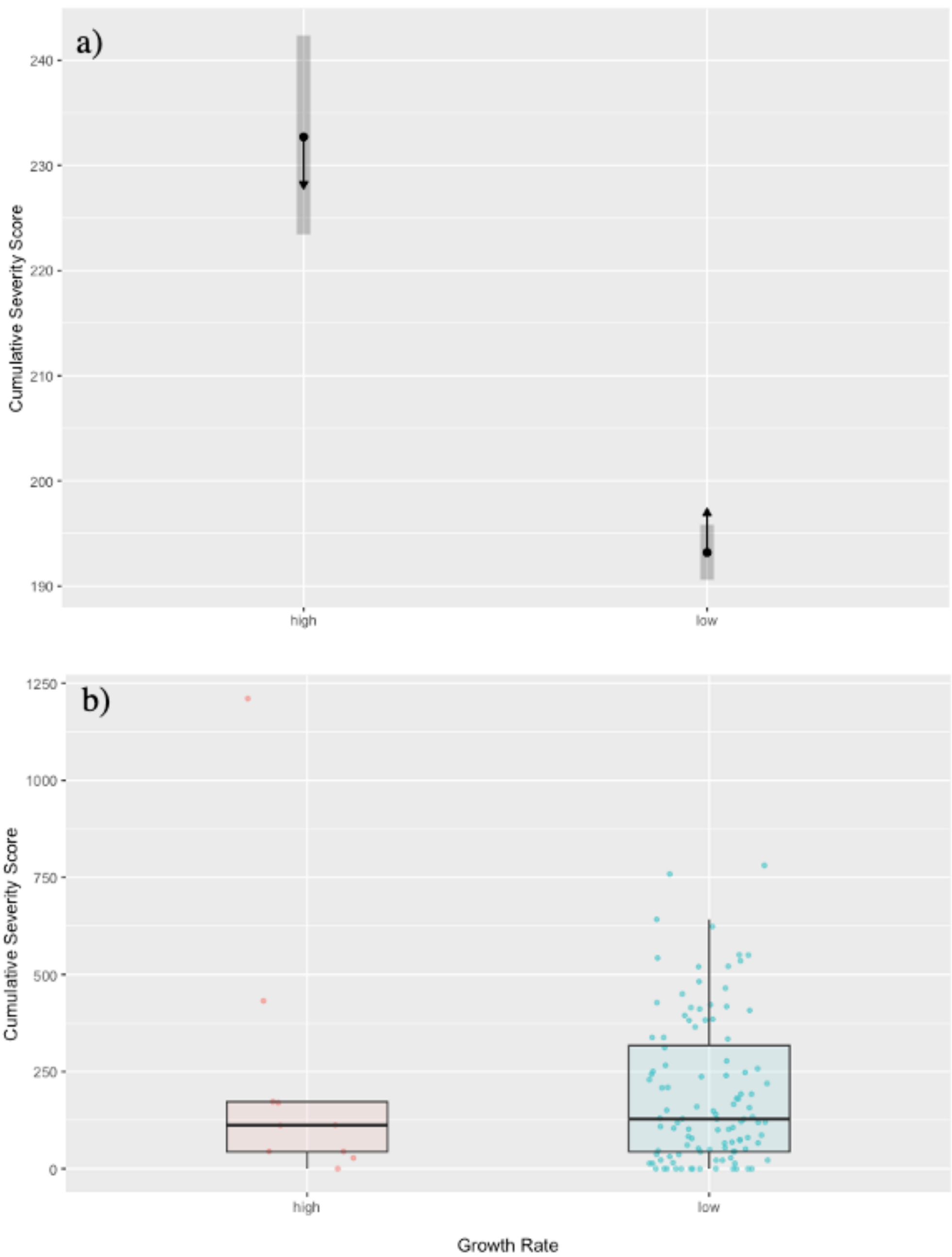

***Figure 11a** - Cumulative severity score for each athlete compared between groups high (>7.2cm/year) and low (<7.2cm/year) growth rates in girls. Black point represents mean estimate, shaded area represents 95 % confidence intervals. Arrows allow for pairwise comparison between groups. **Figure 11b** - Comparison of mean cumulative severity score between the groups of high (>7.2cm/year) and low (<7.2cm/year) growth. The group of girls with high growth rate had higher severity score compared to the girls with low growth rate ($p < 0.0001$). One point represents one athlete.*

Similar findings were done when investigating relationships between cumulative severity scores of substantial health problems and growth rate in girls, were we found a non-linear relationship ($p < 0.001$). Peak estimated cumulative severity score of substantial health problems was observed in growth rates lower than 0.6 cm/year and higher than 8.5 cm/year.

The group of girls with high growth rate, had 24.6 % higher severity score of substantial health problems compared to the group with low growth rates ($p < 0.0001$). There was no relationship between growth rate and number of new health problems reported in boys or girls separately.

Girls had a non-linear relationship with duration of health problems ($p < 0.001$). Peak estimated duration was observed in growth rates lower than 0.6 cm/year and higher than 8.5 cm/year. The group with high growth rate were reporting health problems lasting on average 3.8 days longer than girls with low growth rates ($p < 0.0001$).

Non-linear relationship between growth rate and full time-loss was found in girls ($p < 0.001$). Peak estimated full time-loss was observed in growth rates higher than 9.6 cm/year. Partial time-loss had a non-linear relationship with growth rate in girls ($p < 0.001$). Peak estimated partial time-loss was observed in growth rates lower than 2.8 cm/year and higher than 8.5cm/year. Total time-loss had a non-linear relationship with growth rate in girls ($p < 0.001$). Peak estimated total time-loss was observed in growth rates lower than 1.7 cm/year and higher than 8.5 cm/year.

Girls with high growth rates had 5.4 days more of full time-loss compared to girls in lower growth rate group ($p = 0.0001$) and 4.3 days more of total time-loss ($p < 0.0001$). No difference was observed between the groups in partial time-loss.

3.4 Maturity status, growth rate and type of self-reported health problems

3.4.1 Growth rate and type of health problems reported

There was no relationship between growth rate and acute injuries in boys, but a non-linear relationship between growth rate and overuse injuries was found ($p = 0.044$). Peak estimated number of overuse injuries was observed in growth rates above 12.8 cm/year. There was no difference between the groups of high or low growth rate. A linear relationship between growth rate and illness was also observed (RR: 1.09, 95 % CI 1.04-1.14, $p < 0.001$). Here, a group difference was observed ($p < 0.001$; Figure 12), with the high growth rate group estimated to report twice as many (1.2 vs. 0.6) cases of illness compared to the lower growth rate group. No relationship was found between overall injuries and growth rate.

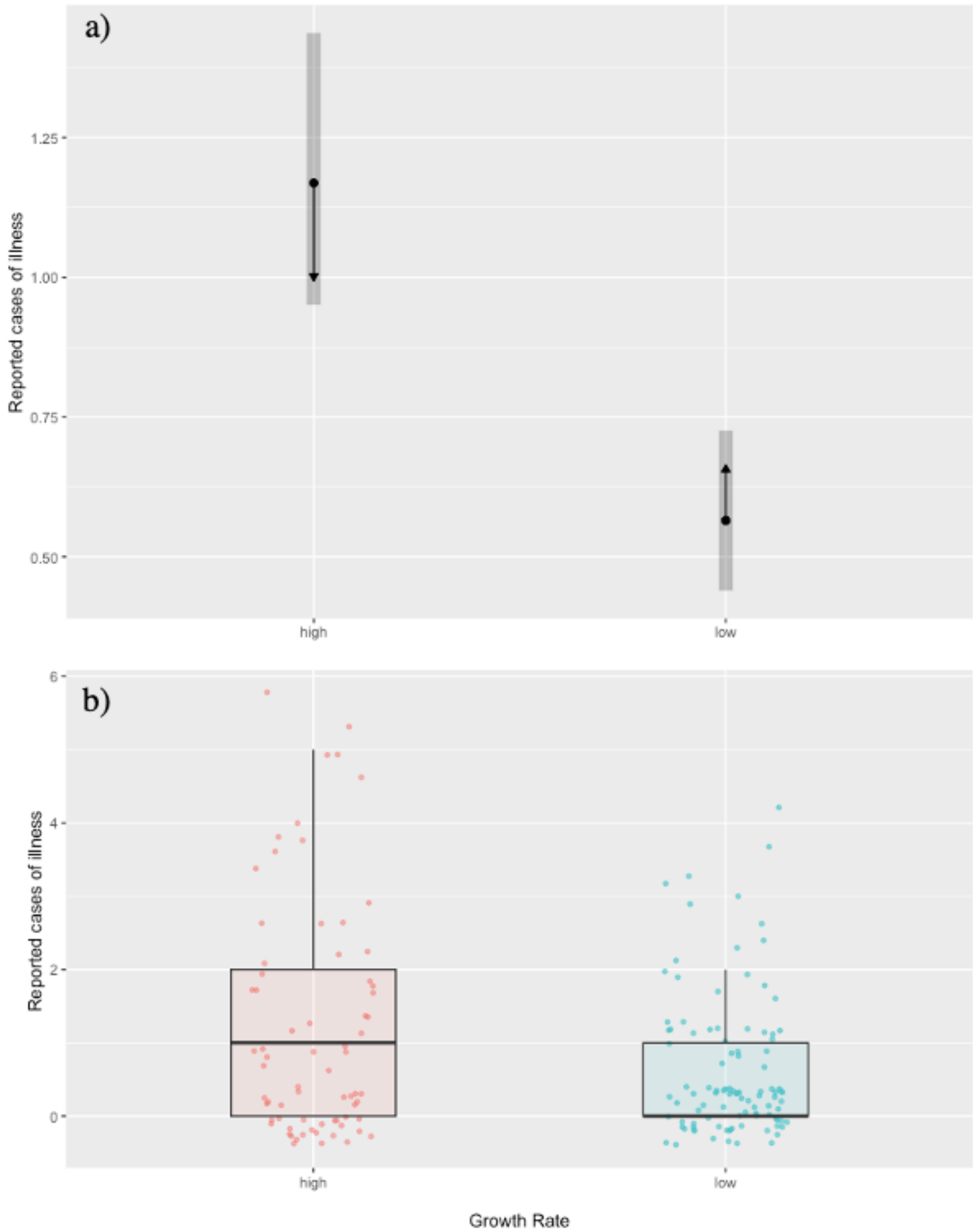

Figure 12a *- Reported cases of illness for each athlete compared between groups of high and low growth rate in boys. Black point represents mean estimate, shaded area represents 95 % confidence intervals. Arrows allow for pairwise comparison between groups.* ***Figure 12b*** *- Comparison reported cases of illness the groups of high (>7.2cm/year) and low (<7.2cm/year) growth.) Boys with high growth rate reported more cases of illness than the boys with low growth rate ($p < 0.001$). One point represents one athlete.*

A linear relationship between growth rate and acute injuries was found in girls (RR: 0.87, 95 % CI 0.79-0.96, $p = 0.006$). A linear relationship with overuse injuries was also observed (RR: 0.94, 95 % CI 0.89-0.99, $p = 0.016$) together with a linear relationship with overall injuries (RR: 0.92, 95 % CI 0.88-0.97, $p = 0.001$). There was no relationship between growth rate and illness in girls, nor any difference between the groups of high and low growth rate in terms of overuse injuries, acute injuries, or overall injuries.

3.4.2 Maturity Status and type of health problems reported

In boys there was no relationship between maturity status and acute injuries. On the other hand, there was a linear relationship between maturity status and overuse injuries (RR: 1.07, 95 % CI 1.03-1.11, $p = 0.001$). There was also a linear relationship between maturity status and illness (0.92, 95 % CI 0.88-0.96, $p < 0.001$). No relationship between maturity status and overall injuries was observed. There were no differences between the three groups of different maturity status and overuse injuries or acute injuries. Boys pre-PHV reported more cases of illness than boys post-PHV (1.2 vs 0.5, $p = 0.0191$; Figure 13), and boys cirka-PHV reported more cases of illness compared to boys post-PHV (1.0 vs 0.5, $p = 0.0120$; Figure 13).

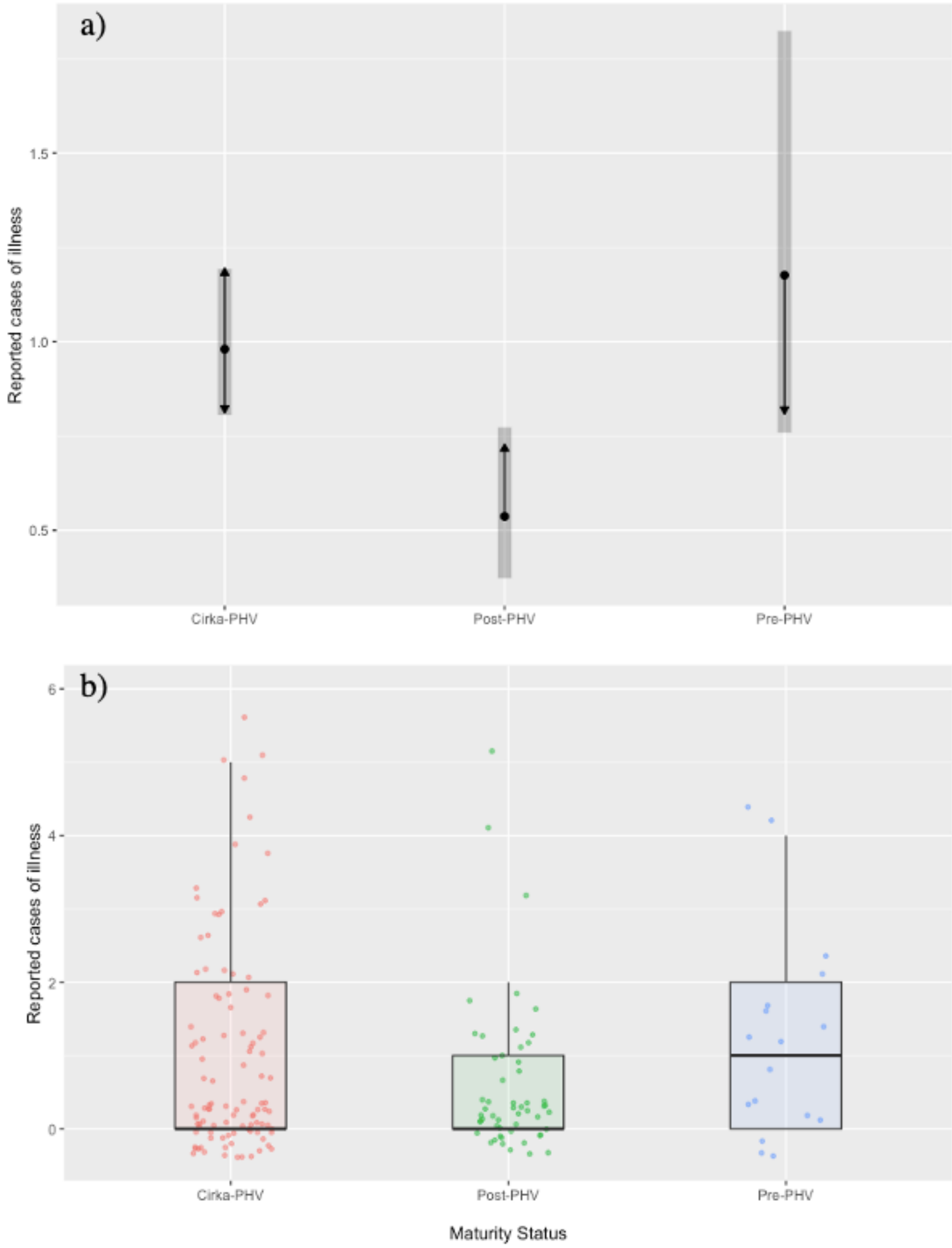

Figure 13a *- Reported cases of illness for each athlete compared between groups of different maturity status in boys. Black point represents mean estimate, shaded area represents 95 % confidence intervals. Arrows allow for pairwise comparison between groups. (PHV; Peak Height Velocity)* ***Figure 13b*** *- Comparison of reported cases of illness between the three groups of different maturity status in boys. Boys pre-PHV reported more cases of illness than boys post-PHV (p = 0.0191) and boys cirka-PHV reported more cases of illness compared to boys post-PHV (p = 0.0120) One point represents one athlete.*

It was not uncovered any relationship between maturity status and acute injuries in girls, but a non-linear relationship between overuse injuries and maturity status was observed (p = 0.018) The peak estimated number of overuse injuries was observed between 97.2 and 99.2 % POAH. There was no relationship between maturity status and illness in girls. A non-linear relationship between maturity status and overall injuries in girls was found (p = 0.009). Peak estimated number of overall injuries was observed between 97.8 and 99.2 % POAH. There was no difference between the type of health problems reported in groups of different maturity status.

3.5 Prevalence of self-reported health problems among youth athletes

A comparison between genders and type of sports for mean prevalence, severity scores, and duration can be found in Table 3. Almost half of the health problems reported during the period were overuse injuries. Health problems affecting the knee joint (23.1 %, pelvis/low back (9.9 %) and ankle joint (8.1 %) were most common health problem locations. A detailed comparison for types of health problems can be found in Table 4. Mean weekly prevalence ranged from 32 – 42 %.

***Table 3** – Summary and comparison of mean prevalence of health problems, prevalence of substantial health problems, cumulative severity score and duration of health problems. Comparison between genders with differences are shown (*p < 0.05).*

	Health problems	Substantial Health Problems	Cumulative Severity score	Duration
All	36.7%	19.5%	161.6	7.2 days
Boys	32.1%	16.0%	139.2	6.4 days
Girls	44.1%*	25.0%	196.5*	8.4 days*

***Table 4** - Summary of different types of health problems reported, in both all health problems and substantial health problems.*

	All health problems (%)	Substantial health problems (%)
Acute injury	22.8	22.0
Overuse injury	49.4	46.3
Illness	25.3	29.0

3.5.1 Difference between genders

There was no difference between the mean number of reported acute injuries, or number of reported illnesses between genders. Girls reported on average 1.1 more cases of overuse injuries than boys (2.4 vs 1.3, $p < 0.0001$). There was no difference in full time-loss between genders, but girls reported an average of 1.7 days more of partial time-loss compared to their male peers ($p < 0.0001$; Figure 14). When investigating number of new health problems reported, no differences between boys and girls was found.

3.5.2 Differences between sports

In boys, individual sport athletes showed 15.4 % higher prevalence of health problems compared to the team sport athletes ($p = 0.0061$). No difference was observed in prevalence of substantial health problems. Boys competing in individual sports had an estimated average of 64 % higher severity score ($p < 0.0001$), as well a 52 % higher severity score of substantial health problems ($p < 0.0001$) compared to the team sport athletes. They also reported a higher number of new health problems compared to their peers competing in team sports ($p = 0.039$). Individual sport athletes were found to report health problems lasting on average 3.5 days longer than team sport athletes ($p < 0.0001$). Boys competing in team sports and boys competing in individual sport reported similar numbers of acute injuries, but individual athletes reported more illness ($p = 0.0001$) and more overuse injuries ($p = 0.0001$).

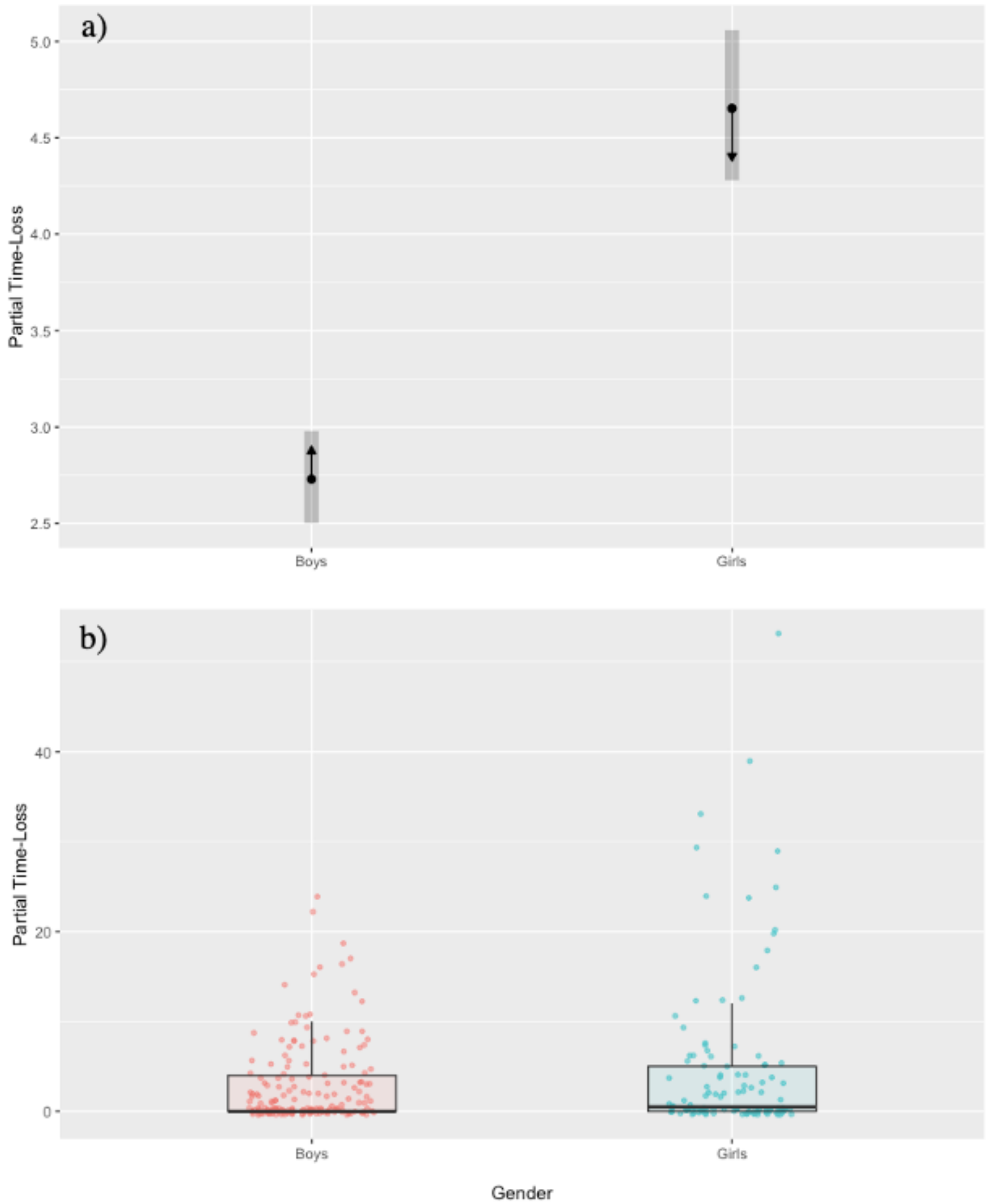

Figure 14a *– Partial time-loss health problems compared between boys and girls. Black point represents mean estimate, shaded area represents 95 % confidence interval. Arrows allow for pairwise comparison between gender.* ***Figure 14b*** *- Comparison of partial time-loss health problems compared between boys and girls. Girls reported more partial time-loss compared to boys (p < 0.0001) One point represents one athlete.*

In girls, there was no difference in prevalence of health problems or substantial health problems when comparing individual sport athletes and team sport athletes. Girls from individual sports were found to have 45 % higher cumulative severity score of all health problems ($p < 0.0001$) and 70 % higher cumulative severity score of substantial health problems ($p < 0.0001$). The mean duration of health problems was also higher among girls competing in individual sports than girls competing in team sports, they reported health problems lasting on average 6 days longer ($p < 0.0001$). Athletes from a team sport environment were found to experience a higher number of acute injuries compared to individual athletes (0.9 vs. 0.5, $p = 0.0170$; Figure 15), while the individual athletes reported a higher number of illnesses (1.6 vs. 0.6, $p < 0.0001$). No differences in overuse injuries were observed.

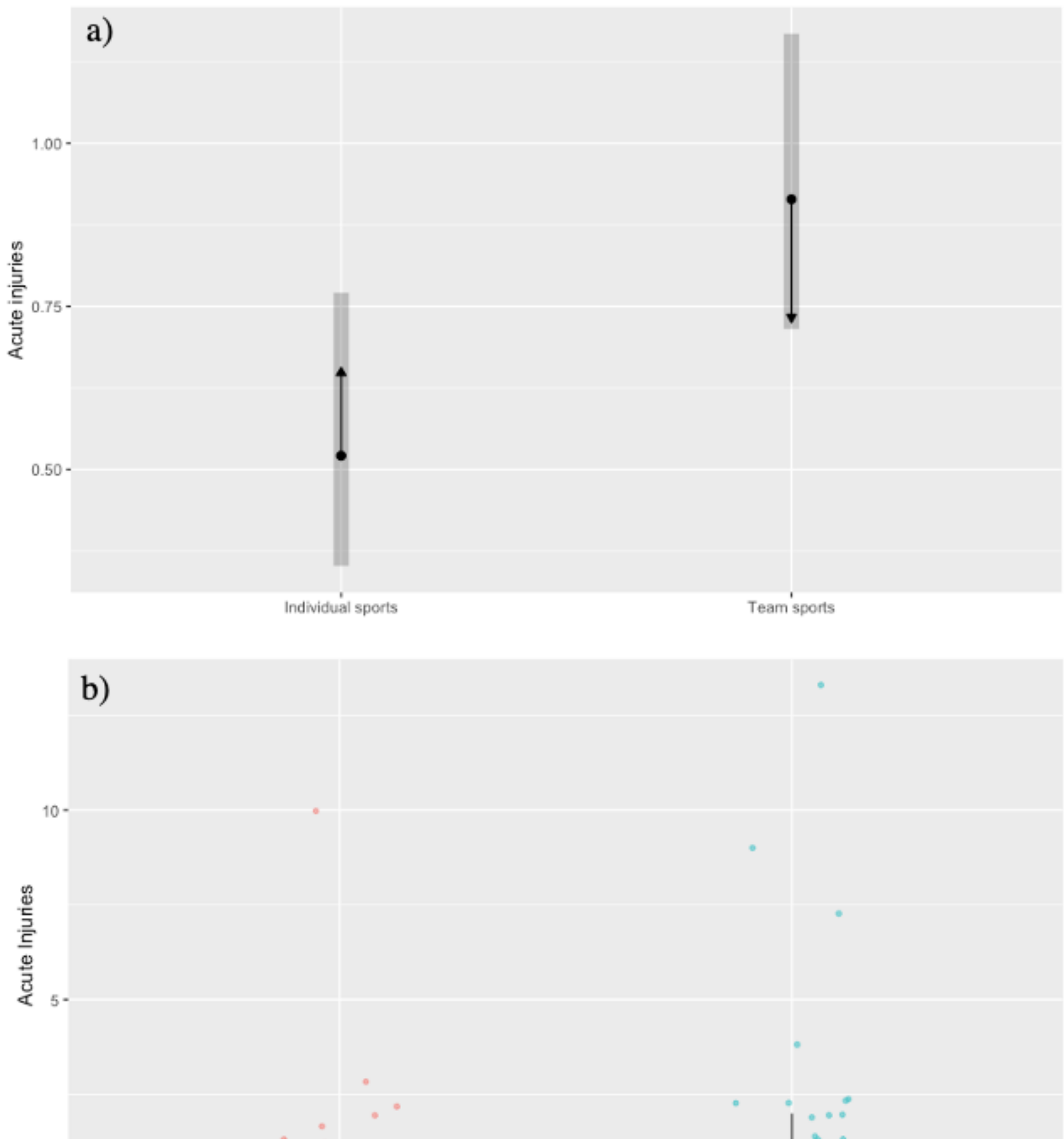

__Figure 15a__ – Number of acute injuries compared between individual and team sports in girls. Black point represents mean estimate, shaded area represents 95 % confidence intervals. Arrows allow for pairwise comparison between sports. __Figure 15b__ - Comparison of number of acute injuries compared between individual and team sports in girls. Athletes from a team sport environment were found to experience a higher number of acute injuries compared to individual athletes ($p = 0.0170$) One point represents one athlete.

4.0 DISCUSSION

4.1 Main findings

The main findings in the present study relates maturity status to self-reported health problems in youth athletes through cumulative severity score of health problems, and of substantial health problems. It also relates maturity status to duration of health problems, and to full time-loss injuries in boys and girls. Peak estimated severity score, duration of health problems and full time-loss were observed between 86.8 and 92.1 % POAH in boys, and above 97.8 % in girls. No relationship was found with prevalence of all health problems, or of substantial health problems in boys or in girls.

Growth rate was related to cumulative severity scores, and duration of health problems as well as to full, partial- and total time-loss in both genders. Boys and girls with growth rates above 7.2cm/year reported higher severity scores, longer duration and more time-loss injuries compared to those with growth rates lower than 7.2cm/year. Both maturity status and growth rate were related to overuse injuries in boys and in girls, as well as being related to illness in boys. Acute and overuse injuries combined were related to maturity status in girls. Boys with high growth rate reported more illness than boys with lower growth rate, and boys pre-PHV reported more illness than boys cirka- and post-PHV.

Finally, this study found a 36.7 % prevalence of all health problems, and 19.5 % prevalence of substantial health problems. Girls had higher prevalence of all health problems than boys, as well as higher cumulative severity score and longer duration of health problems.

4.2 Results and previous research

The lack of relationship between maturity status and growth rate with prevalence of health problems was in contrast with out hypothesis. The current findings relating maturity status to health problems are in line with previous findings by Johnson et al. (2022), where higher injury incidence and injury burden were shown to have a non-linear relationship with maturity status (D. M. Johnson et al., 2022). In the mentioned study, the highest risk of injury and burden was estimated to be between 92 and 95 % POAH. The highest likelihood of injury was estimated to be at 92 % POAH, and the period between 83 % and 93 % was shown to be strongly related to change in injury likelihood. These estimations are similar to what has been presented in this study, and supports our hypothesis to some degree, highlighting the period of cirka-PHV between 88 and 95 % POAH. However, it is still difficult to compare the results directly due to differences in definitions and methods used to report injury. Nevertheless, the results in our study as well as presented by Johnson et al. (2022), might suggest that the period equivalent to entering PHV is when youth athletes are most exposed to burdensome injuries. Studies including youth male academy football players found injury risk and injury burden to be highest in players cirka-PHV (D. Johnson et al., 2019; Monasterio et al., 2021), but lower in players pre-PHV, compared to players cirka- and post-PHV (D. Johnson et al., 2019; Monasterio et al., 2021). If severity score and duration of health problems can be interpreted as surrogates for injury burden, this is in contrast with our findings. In girls, the group differences in maturity status were quite substantial. Athletes post-PHV reported two times as high severity score of all health problems, and more than three and half times as high severity score of substantial health problems. The girls post-PHV also reported health problems lasting on average 5 days longer than girls cirka-PHV. The findings from group comparisons in boys and in girls are in complete contrast to our hypothesis, and also in contrast to previous studies conducted on boys. Distribution of athletes s in the groups of different maturity status, as well as the results from non-linear regression analysis in this study could contribute to explain these contrasting results. When analysing between-group differences, the analysis might be affected by the fact that the pre-PHV group only includes 17 athletes, out of which are all boys (Table 2). The self-reported health problems of each athlete in this group will therefore be weighted higher than athletes in the corresponding groups, which is possibly affecting the results. According to Malina (2004) the inclusion of participants between the age of 12 and 16 years should provide a sample of boys and girls before, during and after PHV (Malina et al., 2004). However, considering the on average earlier take off in maturation of girls, the sample of girls included in the study were likely to be more mature compared to the boys. This was also confirmed when analyzing the maturity status of girls, which was found to be significantly higher than the boys (Table 1). We will present further how trends in girls differ from boys in term of the relationships between injury and growth and maturation.

Previous studies have reported that higher incidence and higher injury risk is related to higher growth rates in male youth athletes (D. M. Johnson et al., 2022; Kemper et al., 2015; Rommers et al., 2020; Wik et al., 2020). This corresponds to the results presented in our study where a linear relationship was found between cumulative severity score and growth rate in boys. Boys and girls with growth rates above 7.2cm/year were also reporting higher severity scores and longer duration of health problems compared to peers with growth rates lower than

7.2cm/year. This is in agreement with our hypothesis as well as with what has been highlighted by Johnson et al. (2022) and Kemper et al. (2015) in studies including boys from an academy football setting (D. M. Johnson et al., 2022; Kemper et al., 2015). Interestingly, in girls the relationship between growth rate and severity score was non-linear, and peak estimated severity scores were observed both in growth rates lower than 1.7cm/year, and in growth rates above 8.5cm/year. It is possible that this can be explained by the skewness of data towards lower growth rates among girls participating in this study, where roughly 8 % of the girls had growth rates higher than 7.2cm/year. The comparisons between groups of different growth rates in girls, has the chance of being affected in the same way as the mentioned comparison of maturity status.

Schoeb et al. (2020) showed a relationship between biological maturation, using a maturity offset method and cumulative severity score of acute injuries. In our study, no relationship was found with acute injuries in boys or in girls. On the other hand, both maturity status and growth rate were related to overuse injuries in boys and in girls, but there was no difference between groups of different growth rate or groups of different maturity status in terms of overuse injuries reported. The results from the Poisson regression models supports our hypothesis relating high growth rates to overuse injuries in boys and girls. On the other hand, the between-group differences do not contribute to support our hypothesis relating cirka-PHV and growth rate higher than 7.2cm/year to self-reported health problems. As per Monasterio et al (2021), growth-related injuries have the highest impact cirka-PHV, where growth rates tend to be higher (Malina et al., 2004; Monasterio et al., 2021). These growth-related injuries will also occur pre- and post-PHV, and will often be classified as overuse injuries (Leppänen et al., 2017; Materne et al., 2021a). In line with the distal to proximal injury pattern corresponding with the maturation process, further analysis from this study suggests similar findings. Boys pre-PHV had significantly more knee injuries than post-PHV ($p = 0.0133$) and boys cirka-PHV reported significantly more hip injuries ($p = 0.0449$). Boys post-PHV reported significantly more injuries located in the pelvis and lower back compared to boys post- and pre-PHV ($p = 0.0028$). Boys pre-PHV reported more illness than boys cirka- and post-PHV, while the relationship between maturity status and illness in boys showed that the more mature the athlete was, the fewer cases of illness was reported. A positive relationship between growth rate and illness was also found in boys. This was not observed in the data presented by Schoeb et al. (2020), where data also was collected using OSTRC-H2 (Clarsen et al., 2013; Schoeb et al., 2020). This relationship was not hypothesized prior to our project.

To our knowledge, relationships between illness, growth and maturation are yet to be fully described, but the hormonal changes, as well as changes in both energy demands and energy availability through puberty could potentially have an effect on immune function among adolescent boys (Hannon, Parker, et al., 2021; Malina et al., 2004; Veldhuis et al., 2005; Wasserfurth et al., 2020).

The present findings of a 36.7 % prevalence of all health problems, and a 19.5 % prevalence of substantial health problems are in correspondence with previous studies on health problems among youth athletes. Prevalence of all health problems has been shown to vary between 25 and 65 %, and prevalence of substantial health problems have varied between 16 and 25 % (Dalen-Lorentsen et al., 2021; Moseid et al., 2018; Nordstrøm et al., 2021; Schoeb et al., 2020). However, due to different assessment methods and definitions among the studies, it is difficult to draw any conclusions.

It could be reasonable to argue that our study is closely related to the study conducted by Moseid et al. (2018), where athletes from both genders and from team- and individual sports, attending Norwegian Sports Specialized Schools have been included. Similar procedures for collecting injury data were also used. On the contrary, the youth athletes included in our study were younger (average 14.0 years of age compared 16.2 years) and therefore more likely to include athletes before and during PHV (Malina et al., 2004; Moseid et al., 2018). This could potentially contribute to the differences observed between the studies, as the sample in our study should contain athletes who on average are less mature and has higher growth rates. In addition, results from our study shows a lower prevalence of all health problems and of substantial health problems. This can possibly be linked to a lower training volume and exposure - which is normally lower with lower age, and the possible relationship between training load and injury (Bache-Mathiesen et al., 2022; Hannon, Coleman, et al., 2021; Read et al., 2018; Windt & Gabbett, 2017). At the same time, our results showed a surprisingly higher amount of overuse injuries (49 % vs. 26 %) compared to what was described in Moseid et al (2018). With assumingly lower training exposure in younger athletes, it is possible to argue that the higher amount of overuse injuries could be linked to a higher amount of growth-related injuries which are also more prevalent in this younger and probably less mature sample (Monasterio et al., 2021). When delving into time-loss data, the results in this study show that approximately 55 % of total time-loss is classified as partial time-loss.

This is more than twice as much as described by Veith et al (2022). Despite taking different methods of data collection into account, this could possibly be explained by a higher amount of growth-related injuries or overuse injuries, where treatment protocols often include longer periods of load management and reduced participation in sport (Rathleff et al., 2020).

4.3 Methodological considerations

The use of the OSTRC-H2 allowed the present study for a validated and cost-effective injury data collection (Clarsen et al., 2014). This enabled comparisons with studies using the same validated questionnaire, and provides comparable injury definitions to international consensus statements (Bahr et al., 2020; Dalen-Lorentsen et al., 2021; Fuller et al., 2006; Moseid et al., 2018; Schoeb et al., 2020). The severity score used in this study is a staple of the OSTRC-H2 and is described as an objective measure of an athletes' self-assessed consequences of a health problem. The severity score can also be used as a measure of the progress of health problems during a study, and reflects what impact the health problem has had on an athletes participation, training volume and sports performance (Clarsen et al., 2013). While giving this study a base for comparison and a cost-effective injury data collection, the questionnaire is yet to be validated on individuals at comparable ages to our sample. Collection of injury data through this questionnaire also brings some diagnostic challenges, especially in regard to physeal or growth-related injuries that account for a large part of injuries among youth athletes (Materne et al., 2021a; Monasterio et al., 2021) For future studies, the possibility of distributing the questionnaires every second or every fourth week can also be considered (Clarsen et al., 2020). At the same time, results from our study show that time spent on responding to the questionnaires was on average 62 seconds per answer. The potential benefit of longer intervals between distribution of questionnaires are therefore thought to be limited. Another strength and possible positive effect of weekly distribution is overall compliance, in terms of not being as susceptible to students being absent from school on the given day of data collection.

A limitation in the present study is that it has not accounted for training exposure, which limits the possibility for comparison to other similar studies (Dalen-Lorentsen et al., 2021; D. M. Johnson et al., 2022; Materne et al., 2021b; Wik et al., 2020). It also limits the possibility of measuring incidence in a traditional manner e.g., as occurrence per 1000 hours exposure. Still, according to the latest IOC consensus statement this can also be reported as number of new health problems reported, or as number of new cases divided by a period of time (Bahr et al., 2020). Moreover, and unfortunately, due to the time limit on this thesis, and further logistical and economic reasons the study period in the present study was limited to approximately 13 weeks. This is shorter than the latest recommended time frames regarding research on growth, maturation and injury (Swain et al., 2018; Towlson et al., 2021). In both research and in practice athletes should preferably be monitored for longer periods, given both the time frames and non-linear nature of growth and maturation, as well as possible errors related to anthropometric measurements and estimations of somatic maturation (Salter et al., 2022; Swain et al., 2018; Towlson et al., 2021).

We have analysed and presented results in this study by gender, by sport and by different groups of growth rate or maturity status. The large sample size is an obvious strength to this study, which together with the compliance of the weekly questionnaires were comparable to other similar studies (Dalen-Lorentsen et al., 2021; Moseid et al., 2018). While the number of participants is a total of 303 youth athletes, the statistical analysis can be affected by grouping based on gender. From an epidemiological point of view, it could be more reasonable to combine all the athletes to gather more cases of health problems to one single analysis. This would have increased the chance of uncovering small to moderate associations between growth, maturation and injury (Bahr & Holme, 2003). Grouping by gender can potentially also lead to the study being more susceptible to type-I errors (Ranganathan et al., 2016). Despite this, the included number of athletes in the analysis is still considered adequate to find moderate to strong associations (Bahr & Holme, 2003). Statistically, a combination of girls and boys in the same dataset can potentially enhance the effects of an already skewed dataset of independent predictor variables, due to the mentioned differences in maturity and growth rate between boys and girls (Table 1, Table 2). If the distribution of the independent variables between boys and girls were more homogenous, it could have been more valuable to combine the data prior to analysis from a statistical and epidemiological point of view. Furthermore, from a practical standpoint, it could be less sensible to combine these results in the analysis due to the different characteristics of youth sports in boys and girls. This is still prevalent despite looking further than the developmental and physical differences between genders during puberty (Malina et al., 2004).

Furthermore, this study is strengthened through the use of linear and non-linear Poisson regression models, which accounts for the zero-inflated distribution of multiple dependent variables and allows for comparison beyond the non-parametric between-group comparisons.

Comparison of estimated means and peak estimation values of dependent variables serves a detailed insight to a dataset with somewhat heterogenous distribution of independent variables such as growth rate and maturity status. Statistically it could also be possible to strengthen the statistical level of the study even more by combining both predictor variables in the analysis to broaden the view on how these interact, which is similar to what some authors have done before (D. M. Johnson et al., 2022).

The use of the Khamis-Roche method to indicate maturity status of the individuals through use of percentage of adult height, is currently viewed as an adequate surrogate for more costly measures as e.g. skeletal age (Khamis & Roche, 1994; Salter et al., 2022). The decision to use this method for equation of somatic maturation contributed to a larger sample size, and therefore strengthens the study despite having limitations (Lolli et al., 2022). Together with the implemented testing protocols in this study, there are other possible measures to minimize the errors associated with this method. These include extension of the study period and use of subsequent statistical measurements to enhance contextualization of the data collected (Towlson et al., 2021). Due to missing data and evidence of anthropometric measurements of sitting height not following the testing protocols developed and distributed for this study, these measurements were removed from the analysis due to risk of bias.

4.4 Contributions to the current field

This study has introduced and implemented an easy, time-efficient, and cost-effective injury data collection to Norwegian Sport Specialised Secondary Schools, and we have improved testing protocols and understanding of data among coaches and clinicians. We also believe we have educated athletes, coaches, teachers, and parents on how growth and maturation affect adolescent boys and girls. This study has contributed to create interest and cooperation with multiple schools and clubs in the local districts, as well as opened talks with sports federations regarding development of framework for better management of growth and maturation in athletic development. We aim to contribute to more knowledge around growth and maturation through publication of this thesis, through presentation of data in seminars and in relevant media channels. Hopefully, the present study will create possibilities for more robust studies investigating these common issues in further detail and to a greater extent. In the future, greater knowledge surrounding growth, maturation and health problems can lead to better implementation of effective preventative measures and increase athletic development.

5.0 CONCLUSION

In this study maturity status and higher growth rate was related to self-reported health problems in youth athletes through severity score of health problems, severity score of substantial health problems, and duration of health problems in boys and in girls. Maturity status and higher growth rates is also related to full time-loss in both boys and girls. Both maturity status and growth rate were related to overuse injuries in boys and in girls, as well as both being related to illness in boys. Studies of longer duration, a more evenly distributed sample and subsequent statistical measures is needed to conclude further around the details of these relationships.

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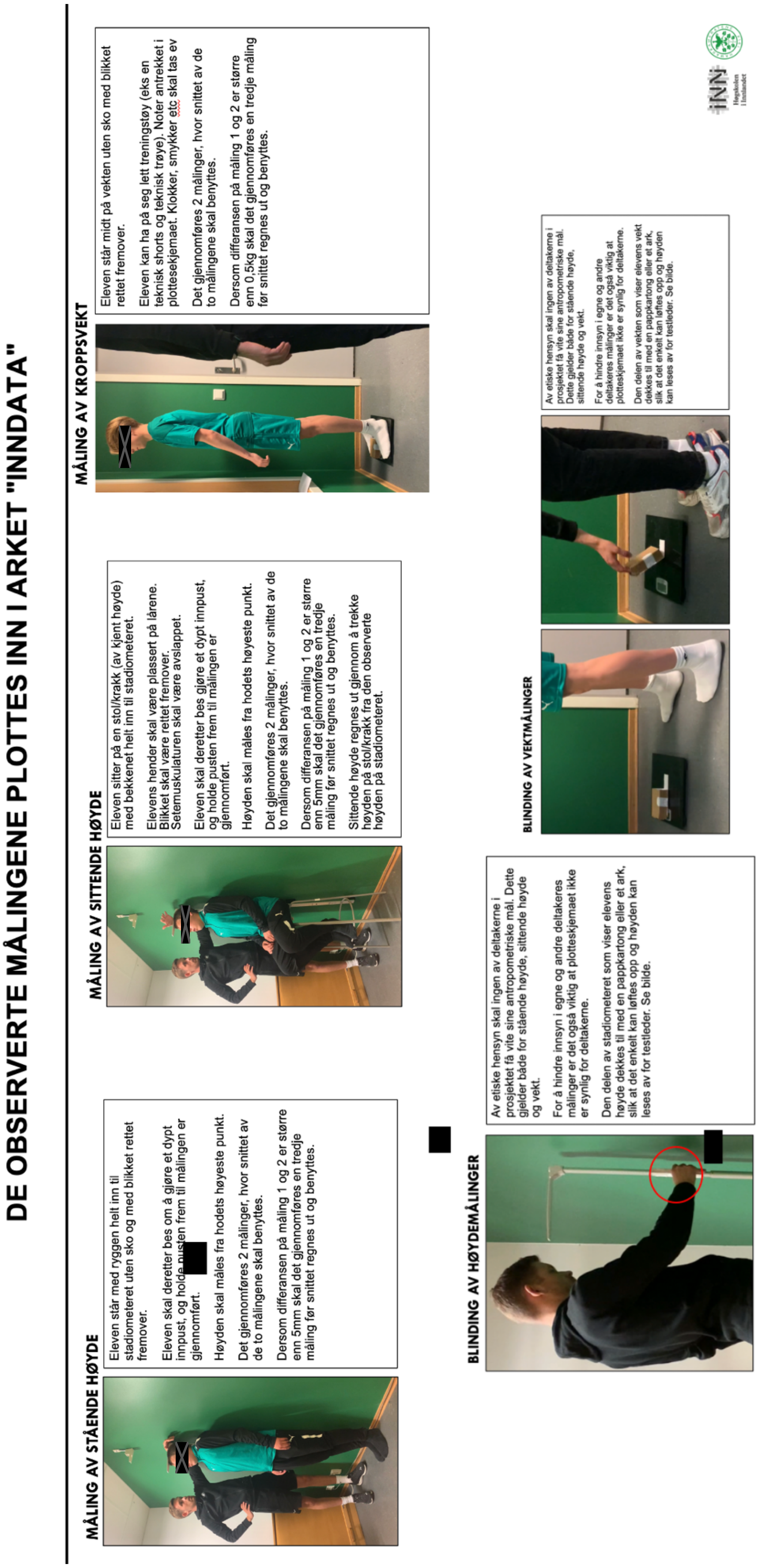
7.0 ATTACHMENTS

7.1 Attachment 1 - Data collection protocol for anthropometric measurements



7.2 Attachment 2 - Example of distributed information letter

INFORMASJON OM FORSKNINGSPROSJEKTET:

PÅVIRKNING AV MODNING OG VEKST PÅ HELSEPLAGER HOS IDRETTSUNGDOM

Bakgrunn og hensikt

I Norge finnes det i dag flere idrettsskoler der unge idrettsutøvere får tilrettelagt hverdagen for å kunne kombinere idrettsaktivitet med skolegang. Det finnes skoler over hele landet som tilbyr en slik tilrettelegging på videregående og ungdomsskole, i et bredt utvalg av ulike idretter. I tenårene går man samtidig gjennom en prosess der kroppen er i stor endring, spesielt i kroppssammensetning, høyde og vekt. I løpet av denne prosessen går jenter og gutter gjennom ulike faser av vekst hvor man vokser i ulikt tempo og omfang. Perioden i tenårene med raskest økning i vekst har i ulike idretter vist seg å kunne være forbundet med økt risiko for skader. Det er store individuelle forskjeller i hvilke tidspunkt man går gjennom denne perioden, som kan gjøre det utfordrende for helsepersonell og andre aktører i idretten å plukke opp. Hittil er det ikke gjort studier som sammenligner modning og vekst med forekomsten av skader og sykdom på idrettsungdom på ungdomsskolenivå, og det er en varierende praksis i kartleggingen av modning og vekst blant denne gruppen.
For å kunne iverksette forebyggende tiltak rettet disse utfordringene hos unge utøvere må omfanget og forekomst først kartlegges, og eventuelle sammenhenger må undersøkes. Hensikten med prosjektet er derfor å kartlegge forekomsten av helseplager i form av skader og sykdom blant idrettsungdom og undersøke hvorvidt det er en sammenheng mellom vekst, modning og rapporterte helseplager. Vi ønsker å følge ungdommene over 13 ukers periode. I forkant og etterkant av denne perioden vil det blir gjort en kartlegging av ungdommenes vekst og modningsstatus. Kartleggingen vil bli gjort gjennom måling av høyde, vekt og sittende høyde, i tillegg til at vi innhenter selvrapportert høyde fra forsøkspersonenes biologiske foreldre i forkant av første tidspunkt for måling. Dette informasjonsskrivet er til alle elever som går på norske idrettsskoler på ungdomsskolenivå. Prosjektet er ledet av idrettsseksjonen Lillehammer, Høgskolen Innlandet, ved førsteamanuensis Anne Mette Rustaden. Mastergradsstudent Jacob Mollatt er tilknyttet prosjektet.

Hva innebærer studien?

Som forsøksperson må du besvare ukentlige spørreskjema om din deltakelse i trening. Disse spørreskjemaene er elektroniske, og består av 1-5 deler avhengig av svarene du oppgir. Spørsmålene handler deltakelse i trening, treningsmodifikasjon, prestasjonsevne og symptomer. Hele skjemaet tar i underkant av tre minutter å gjennomføre. I tillegg til dette må man som forsøksperson gjennomføre måling av høyde, vekt og sittende høyde ved to tidspunkter med omtrent 13 ukers mellomrom. Du vil ikke få vite resultatene fra de to måletidspunktene av etiske hensyn. Vi vil i samarbeid med skolen tilrettelegge gjennomgang av spørreskjema og målinger så godt som mulig, slik at det skal være enkelt å gjennomføre. Alle testene blir gjennomført på samme sted, under tilnærmet like forhold og innenfor samme tidsrom på døgnet. Som deltaker vil dine biologiske foreldre også bli forespurt om å oppgi sin høyde.

Mulige fordeler og ulemper

Du som deltaker vil gjennom studiet få en tettere medisinsk oppfølging enn hva du vanligvis får i skolehverdagen og få muligheten til økt kunnskap om en eventuell sykdoms- eller skadesituasjon, modningsstatus og vekst. Har du som deltaker en sykdoms- eller skadeperiode med en varighet på over fire uker vil du raskt kunne motta hjelp og rådgivning fra prosjektmedarbeider, og tidlig bli satt i kontakt med hensiktsmessige instanser. Du kan også kontakte prosjektmedarbeider på hvilket som helst tidspunkt i løpet av studien for spørsmål og råd. I etterkant av studien vil resultater kunne være med å påvirke den enkeltes skolehverdag gjennom at skolen du går på tidlig kan innføre hensiktsmessige tiltak. Den eneste ulempen med deltakelse i prosjektet er den tiden og oppmerksomheten man må avsette til spørreskjema og målinger.

Hva skjer med svarene og informasjonen om deg?

Opplysningene som er innhentet om deg og informasjonen som registreres skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger og prøver gjennom en navneliste, og all data registreres og lagres elektronisk i Tjenester for Sensitive Data (TSD). Forsker er underlagt taushetsplikt og data behandles konfidensielt. Ved publisering av data vil det ikke være mulig å identifisere deg i resultatene. Dataene som fremkommer i studien vil i hovedsak bli benyttet i vitenskapelig artikler, samt bli presentert på nasjonale og internasjonale konferanser og seminar. Av dokumentasjonshensyn blir all data oppbevart avidentifisert i 5 år etter endt prosjekt.

Deltakelse og godkjenning

Regional komité for medisinsk og helsefaglig forskningsetikk har vurdert prosjektet, og har gitt forhåndsgodkjenning (REK 2022/469838).

Det er helt frivillig å delta i prosjektet og du kan når som helst trekke deg uten å måtte begrunne dette nærmere. Dette vil ikke få noen videre konsekvenser for den det måtte gjelde. Som deltaker har man mulighet til å klage til Datatilsynet, og man kan kontakte personvernombudet ved høgskolen. Ved deltakelse i forskningsprosjektet er man forsikret.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet eller ønsker å trekke deg fra deltakelse, kan du kontakte Anne Mette Rustaden, tlf. 612 88 023, anne.rustaden@inn.no.

Dersom du har spørsmål om personvernet i prosjektet, kan du kontakte personvernombudet ved institusjonen: Usman Asghar (usman.asghar@inn.no).

7.3 Attachment 3 – Example of distributed consent form biological parents

VIL DU DELTA I FORSKNINGSPROSJEKTET: «PÅVIRKNING AV MODNING OG VEKST PÅ HELSEPLAGER HOS IDRETTSUNGDOM»?

Formålet med prosjektet og hvorfor du blir spurt

I Norge finnes det i dag flere idrettsskoler der unge idrettsutøvere får tilrettelagt hverdagen for å kunne kombinere idrettsaktivitet med skolegang. Det finnes skoler over hele landet som tilbyr en slik tilrettelegging på videregående og ungdomsskole, i et bredt utvalg av ulike idretter. I tenårene går man samtidig gjennom en prosess der kroppen er i stor endring, spesielt i kroppssammensetning, høyde og vekt. I løpet av denne prosessen går jenter og gutter gjennom ulike faser av vekst hvor man vokser i ulikt tempo og omfang. Perioden i tenårene med raskest økning i vekst har i ulike idretter vist seg å kunne være forbundet med økt risiko for skader. Det er store individuelle forskjeller i hvilke tidspunkt man går gjennom denne perioden, som kan gjøre det utfordrende for helsepersonell og andre aktører i idretten å plukke opp. Hittil er det ikke gjort studier som sammenligner modning og vekst med forekomsten av skader og sykdom på idrettsungdom på ungdomsskolenivå, og det er en varierende praksis i kartleggingen av modning og vekst blant denne gruppen.
For å kunne iverksette forebyggende tiltak rettet disse utfordringene hos unge utøvere må omfanget og forekomst først kartlegges, og eventuelle sammenhenger må undersøkes. Hensikten med prosjektet er derfor å kartlegge forekomsten av helseplager i form av skader og sykdom blant idrettsungdom og undersøke hvorvidt det er en sammenheng mellom vekst, modning og rapporterte helseplager. Vi ønsker å følge ungdommene over 13 ukers periode. I forkant og etterkant av denne perioden vil det blir gjort en kartlegging av ungdommenes vekst og modningsstatus. Kartleggingen vil bli gjort gjennom måling av høyde, vekt og sittende høyde, i tillegg til at vi innhenter selvrapportert høyde fra forsøkspersonenes biologiske foreldre i forkant av første tidspunkt for måling. Dette informasjonsskrivet er til alle foreldre til elever som går på norske idrettsskoler på ungdomsskolenivå.

Prosjektet er ledet av idrettsseksjonen Lillehammer, Høgskolen Innlandet, ved førsteamanuensis Anne Mette Rustaden. Mastergradsstudent Jacob Mollatt er tilknyttet prosjektet.

Hva innebærer prosjektet for deg og ditt barn?

Du forespørres om å la ditt barn delta som forsøksperson i prosjektet. I tillegg, dersom du er biologisk forelder til barnet, forespørres du også om å delta selv ved å oppgi din høyde. Dersom du ikke er biologisk forelder, men har foreldreansvar, kan du samtykke til ditt barns deltakelse. Forsøkspersonene skal besvare ukentlige spørreskjema relatert til deltakelse i trening. Disse spørreskjemaene er elektroniske, og består av 1-5 deler avhengig av svarene som oppgis. Disse spørsmålene omhandler forsøkspersonenes deltakelse i trening, treningsmodifikasjon, prestasjonsevne og symptomer. Hele skjemaet tar i underkant av tre minutter å gjennomføre. I tillegg til dette må man som forsøksperson gjennomføre måling av høyde, vekt og sittende høyde ved to definerte tidspunkter med omtrent 13 ukers mellomrom. Forsøkspersonene vil av etiske hensyn ikke få se eller vite resultatene fra de to måletidspunktene. Vi vil i samarbeid med skolen tilrettelegge gjennomgang av spørreskjema og målinger så godt som mulig, slik at det skal være enkelt å gjennomføre. Alle testene blir gjennomført på samme sted, under tilnærmet like forhold og innenfor samme tidsrom på døgnet. Svarene, opplysninger og resultater fra elektroniske spørreskjema vil bli avidentifisert med et ID-nummer, slik at du ikke vil være identifiserbar.

Mulige fordeler og ulemper for deg og ditt barn

Deltakelse i denne kartleggingsstudien vil ikke gi deg noen direkte personlige fordeler, utover at du bidrar til økt kunnskap om feltet. Gjennom deltakelse kan du bidra til at skolen får kunnskap som på sikt kan føre til at vi finner nye tiltak som forebygger helseplager, og dermed bidra positivt til utøveres helse og utvikling. Den eneste ulempen med deltakelse i prosjektet er den tiden og oppmerksomheten man må avsette til å oppgi informasjon om din høyde.

Som deltaker vil ditt barn gjennom studiet få en tettere medisinsk oppfølging enn hva man vanligvis får i skolehverdagen og få muligheten til økt kunnskap om en eventuell sykdoms- eller skadesituasjon, modningsstatus og vekst. Har deltakeren en sykdoms- eller skadeperiode med en varighet på over fire uker vil de raskt kunne motta hjelp og rådgivning fra prosjektmedarbeider, og tidlig bli satt i kontakt med hensiktsmessige instanser. Deltakere og foresatte vil også kunne kontakte prosjektmedarbeider på hvilket som helst tidspunkt i løpet av studien for spørsmål og råd. I etterkant av studien vil resultater kunne være med å påvirke den enkeltes skolehverdag gjennom at skolen tidlig kan innføre hensiktsmessige tiltak. Den eneste ulempen med deltakelse i prosjektet er den tiden og oppmerksomheten man må avsette til spørreskjema og målinger.

Frivillig deltakelse og mulighet for å trekke samtykke til deg og ditt barn

Det er frivillig å delta i prosjektet. Dersom du og ditt barn ønsker å delta etter å ha lest dette informasjonsskrivet, gir du ditt samtykke ved å krysse av ««ja» i Nettskjema under «Samtykker dere som foreldre til at dere og deres barn deltar i dette forskningsprosjektet?». Dersom du skulle ønske å trekke deg underveis, kan du når som helst og uten å oppgi grunn trekke deg fra prosjektet.

Hva skjer med opplysningene om deg og ditt barn

Opplysningene som registreres om deg og ditt barn skal kun brukes slik som beskrevet under formålet med prosjektet, og planlegges brukt i løpet av 2023. Eventuelle utvidelser i bruk og oppbevaringstid kan kun skje etter godkjenning fra REK og andre relevante myndigheter. Du har rett til innsyn i hvilke opplysninger som er registrert om deg og ditt barn, og har rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Opplysningene du krever innsyn i vil utleveres innen 30 dager. Retten til å få opplysninger slettet/destruert gjelder ikke dersom materialet eller opplysningene er anonymisert eller publisert. Denne rettigheten kan også begrenses dersom opplysningene er inngått i utførte analyser. Dere har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene. Du kan klage på behandlingen av dine og ditt barns opplysninger til Datatilsynet og institusjonen sitt personvernombud.

Alle opplysningene om deg og ditt barn vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger (=kodede opplysninger). En kode knytter opplysninger til deg og ditt barn gjennom en navneliste. Denne listen skal lagres på sikker server hos Tjenester for sensitive data og vil kun være tilgjengelig for prosjektleder Anne Mette Rustaden. Øvrige data skal også lagres på sikker server hos Tjenester for sensitive data, adskilt fra kodelisten.

Publisering av resultater er en nødvendig del av forskningsprosessen. All publisering skal gjøres slik at enkeltdeltakere ikke skal kunne gjenkjennes.
Opplysningene om deg og ditt barn vil bli oppbevart i fem år etter prosjektslutt av kontrollhensyn.

Forsikring

Som forsøksperson i prosjektet er du og ditt barn forsikret gjennom en særskilt forsikringsavtale av Høgskolen i Innlandet gjennom Gjensidige.

FINANSIERING

Prosjektet har ingen finansielle kilder, da det inngår som en del av mastergradsprogrammet i helse- og treningsfysiologi ved Høgskolen i Innlandet. Det finnes derfor ingen økonomiske egeninteresser i prosjektet.

Godkjenninger

Regional komité for medisinsk og helsefaglig forskningsetikk har gjort en forskningsetisk vurdering og godkjent prosjektet (REK 2022/469838).

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Kontaktopplsyninger

Dersom du har spørsmål til prosjektet eller ønsker å trekke deg eller ditt barn fra deltakelse, kan du kontakte Anne Mette Rustaden, tlf. 612 88 023, anne.rustaden@inn.no.

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JEG SAMTYKKER TIL AT JEG OG MITT BARN DELTAR I PROSJEKTET OG TIL AT VÅRE PERSONOPPLYSNINGER BRUKES SLIK DET ER BESKREVET

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7.4 Attachment 4 – Example of consent form distributed to biological parents

VIL DU DELTA I FORSKNINGSPROSJEKTET «PÅVIRKNING AV MODNING OG VEKST PÅ HELSEPLAGER HOS IDRETTSUNGDOM»?

Formålet med prosjektet og hvorfor du blir spurt

I Norge finnes det i dag flere idrettsskoler der unge idrettsutøvere får tilrettelagt hverdagen for å kunne kombinere idrettsaktivitet med skolegang. Det finnes skoler over hele landet som tilbyr en slik tilrettelegging på videregående og ungdomsskole, i et bredt utvalg av ulike idretter. I tenårene går man samtidig gjennom en prosess der kroppen er i stor endring, spesielt i kroppssammensetning, høyde og vekt. I løpet av denne prosessen går jenter og gutter gjennom ulike faser av vekst hvor man vokser i ulikt tempo og omfang. Perioden i tenårene med raskest økning i vekst har i ulike idretter vist seg å kunne være forbundet med økt risiko for skader. Det er store individuelle forskjeller i hvilke tidspunkt man går gjennom denne perioden, som kan gjøre det utfordrende for helsepersonell og andre aktører i idretten å plukke opp. Hittil er det ikke gjort studier som sammenligner modning og vekst med forekomsten av skader og sykdom på idrettsungdom på ungdomsskolenivå, og det er en varierende praksis i kartleggingen av modning og vekst blant denne gruppen.

For å kunne iverksette forebyggende tiltak rettet disse utfordringene hos unge utøvere må omfanget og forekomst først kartlegges, og eventuelle sammenhenger må undersøkes. Hensikten med prosjektet er derfor å kartlegge forekomsten av helseplager i form av skader og sykdom blant idrettsungdom og undersøke hvorvidt det er en sammenheng mellom vekst, modning og rapporterte helseplager. Vi ønsker å følge ungdommene over 13 ukers periode. I forkant og etterkant av denne perioden vil det blir gjort en kartlegging av ungdommenes vekst og modningsstatus. Kartleggingen vil bli gjort gjennom måling av høyde, vekt og sittende høyde, i tillegg til at vi innhenter selvrapportert høyde fra forsøkspersonenes biologiske foreldre i forkant av første tidspunkt for måling. Dette informasjonsskrivet er til dere som biologiske foreldre til elever som går på norske idrettsskoler på ungdomsskolenivå.

Prosjektet er ledet av idrettsseksjonen Lillehammer, Høgskolen Innlandet, ved førsteamanuensis Anne Mette Rustaden. Mastergradsstudent Jacob Mollatt er tilknyttet prosjektet.

Hva innebærer prosjektet for deg?

Du som biologisk forelder forespørres om å delta i prosjektet gjennom å oppgi din høyde. Forsøkspersonene(elevene) skal besvare ukentlige spørreskjema relatert til deltakelse i trening. Disse spørreskjemaene er elektroniske, og består av 1-5 deler avhengig av svarene som oppgis. Disse spørsmålene omhandler forsøkspersonenes deltakelse i trening, treningsmodifikasjon, prestasjonsevne og symptomer. Hele skjemaet tar i underkant av tre minutter å gjennomføre. I tillegg til dette må man som forsøksperson gjennomføre måling av høyde, vekt og sittende høyde ved to definerte tidspunkter med omtrent 13 ukers mellomrom. Forsøkspersonene vil av etiske hensyn ikke få se eller vite resultatene fra de to måletidspunktene. Vi vil i samarbeid med skolen tilrettelegge gjennomgang av spørreskjema og målinger så godt som mulig, slik at det skal være enkelt å gjennomføre. Alle testene blir gjennomført på samme sted, under tilnærmet like forhold og innenfor samme tidsrom på døgnet. Svarene, opplysninger og resultater fra elektroniske spørreskjema vil bli avidentifisert med et ID-nummer, slik at du ikke vil være identifiserbar.

Mulige fordeler og ulemper

Deltakelse i denne kartleggingsstudien vil ikke gi deg noen direkte personlige fordeler, utover at du bidrar til økt kunnskap om feltet. Gjennom deltakelse kan du bidra til at skolen får kunnskap som på sikt kan føre til at vi finner nye tiltak som forebygger helseplager, og dermed bidra positivt til utøveres helse og utvikling. Den eneste ulempen med deltakelse i prosjektet er den tiden og oppmerksomheten man må avsette til å oppgi informasjon om din høyde.

Frivillig deltakelse og mulighet for å trekke ditt samtykke

Det er frivillig å delta i prosjektet. Dersom du ønsker å delta etter å ha lest dette informasjonsskrivet, gir du ditt samtykke ved å krysse av ««ja» i Nettskjema under «Samtykker dere som foreldre til at dere og deres barn deltar i dette forskningsprosjektet?», og oppgir din høyde i feltet under. Dersom du skulle ønske å trekke deg underveis, kan du når som helst og uten å oppgi grunn trekke deg fra prosjektet.

Hva skjer med opplysningen om deg?

Opplysningene som registreres om deg skal kun brukes slik som beskrevet under formålet med prosjektet, og planlegges brukt i løpet av 2023. Eventuelle utvidelser i bruk og oppbevaringstid kan kun skje etter godkjenning fra REK og andre relevante myndigheter. Du har rett til innsyn i hvilke opplysninger som er registrert om deg, og rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Opplysningene du krever innsyn i vil utleveres innen 30 dager. Retten til å få opplysninger slettet/destruert gjelder ikke dersom materialet eller opplysningene er anonymisert eller publisert. Denne rettigheten kan også begrenses dersom opplysningene er inngått i utførte analyser. Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene. Du kan klage på behandlingen av dine opplysninger til Datatilsynet og institusjonen sitt personvernombud.

Alle opplysningene om deg vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger (=kodede opplysninger). En kode knytter opplysninger til deg gjennom en navneliste. Denne listen skal lagres på sikker server hos Tjenester for sensitive data og vil kun være tilgjengelig for prosjektleder Anne Mette Rustaden. Øvrige data skal også lagres på sikker server hos Tjenester for sensitive data, adskilt fra kodelisten.

Publisering av resultater er en nødvendig del av forskningsprosessen. All publisering skal gjøres slik at enkeltdeltakere ikke skal kunne gjenkjennes. Opplysningene om deg vil bli oppbevart i fem år etter prosjektslutt av kontrollhensyn.

Forsikring

Som forsøksperson i prosjektet er du forsikret gjennom en særskilt forsikringsavtale av Høgskolen i Innlandet gjennom Gjensidige.

FINANSIERING

Prosjektet har ingen finansielle kilder, da det inngår som en del av mastergradsprogrammet i helse- og treningsfysiologi ved Høgskolen i Innlandet. Det finnes derfor ingen økonomiske egeninteresser i prosjektet.

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