DAILY PHYSICAL ACTIVITY AND PHYSICAL ACTIVITY IN SOCCER PRACTICE WITH CHILDREN

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ABSTRACT

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Physical activity varies between individuals. Different amounts and intensities of physical activity is attained throughout the day, mostly during leisure time. Recommendations for daily physical activity give guidelines for the amounts of PA for children. More and more children are unable to meet these recommendations and division into high- and low-active children has become evident. Participation into organized sport has been seen as one possible solution to increase children's PA. However, there are studies showing that participation into organized sport does not actually increase children's overall PA. Little research has focused on the relationship of PA preceding organized sport sessions on the same day with children.

In this study daily activity of 12 to 13 year old boys (N = 18) engaged in soccer was measured for 10 days with Polar A300 activity meters. The measurement period consisted of days with and without practices and took place in February 2017 in Jyväskylä, Finland. The data was analyzed to see whether preceding activity on the same day before the practice on any level had any relationship with activity on any level during practices. From the data analysis were made also to distinguish overall PA, PA during practices, PA difference between days with and without practice as well as between weekdays and weekend days. In addition the study group was divided into upper and lower half based on participants' daily MVPA to study differences in PA between these two groups during practices and other times.

Main finding of this study was that PA on different intensity levels during the day, preceding soccer practice on the same day has positive correlation with PA on different intensity levels during practice. The correlation was statistically significant for several different activity levels, highest correlation coefficient varying between $0{,}834 < r < 0{,}808$ with $p < 0{,}001$ for preceding LPA and practice time MPA. This gives indications that being physically active already before the practice on the same day promotes PA also during the practice session. The results also suggest that no preceding physical activity at any intensity level decreases PA during practice session. Another important finding was that children engaged in sports club do not necessarily get the recommended amount of PA on days without practice, especially on weekends. E.g. the average amount of VPA on weekend days without practice was 18 ± 30 min, compared to 61 ± 31 min ($p < 0{,}010$) on weekend days with practice. This makes it important to promote PA even for children involved in organized sport. These findings also support the importance of daily PA in children.

Key words: children, physical activity, acute physical activity preceding practice, soccer

TIIVISTELMÄ

Ala-Kitula, A. 2017. Lasten päivittäinen fyysinen aktiivisuus ja fyysinen aktiivisuus jalkapalloharjoituksissa. Liikuntatieteellinen tiedekunta, Jyväskylän yliopisto, liikuntafysiologian pro gradu -tutkielma, 60 s., 2 liitettä.

Päivittäisen fyysisen aktiivisuuden määrässä ja intensiteetissä on eroja ihmisten välillä. Suurin osa fyysisestä aktiivisuudesta tapahtuu vapaa-ajalla, lapsilla koulupäivän ulkopuolella. Liikuntasuositukset ohjeistavat riittävästä päivittäisen fyysisen aktiivisuuden määrästä ja laadusta. Yhä useammat lapset eivät saavuta näitä suosituksia ja jako aktiivisiin ja vähemmän aktiivisiin lapsiin on tullut entistä selkeämmäksi. Osallistumista ohjattuun liikuntaan on pidetty yhtenä ratkaisuna lisätä lasten päivittäisen fyysisen aktiivisuuden määrää. Tutkimukset kuitenkin ovat osoittaneet, ettei järjestettyyn liikuntaan osallistuminen kasvata lasten kokonaisaktiivisuutta. Saman päivän aikana tapahtuvan edeltävän aktiivisuuden merkitystä harjoitusten aikaiseen aktiivisuuteen on tutkittu lapsilla vähän.

Tässä tutkimuksessa mitattiin 18:n 12–13 -vuotiaan pojan päivittäistä aktiivisuutta Polar A300 -aktiivisuusmittarilla. Mittausjakso kesti 10 päivää ja jaksoon sisältyi sekä päiviä ilman harjoituksia että harjoituspäiviä. Mittaukset tehtiin Jyväskylässä helmikuussa 2017. Kerätystä aktiivisuusdatasta analysoitiin mahdollista harjoitusta edeltävän saman päivän aikaisen aktiivisuuden vaikutusta harjoitusten aikaiseen aktiivisuuteen. Lisäksi datasta tutkittiin lasten päivittäisen aktiivisuuden määrää viikolla ja viikonloppuna, päivinä, jolloin harjoituksia ei ollut ja harjoituspäivinä sekä harjoitusten aikaista aktiivisuutta. Tutkimusryhmä jaettiin myös aktiivisiin ja vähemmän aktiivisiin lapsiin, jotta voitiin analysoida eroja näiden ryhmien välillä päivittäisessä ja harjoitusten aikaisessa aktiivisuudessa.

Tutkimuksen päätuloksena havaittiin, että päivän aikainen harjoituksia edeltävä aktiivisuus monella eri intesiteettitasoilla korreloi positiivisesti harjoitusten aikaisen aktiivisuuden kanssa useilla eri aktiivisuustasoilla, kun harjoituksia katsotaan yksittäin. Tilastollisesti merkitseviä korrelaatioita löydettiin useiden eri fyysisen aktiivisuuden intensiteettitasojen kesken suurimpien korrelaatiokerroinarvojen vaihdellessa välillä 0,834–0,808, $p < 0,001$. Tulos antaa viitteitä siitä, että harjoituksia edeltävä aktiivisuus etenkin LPA-tasolla lisää aktiivisuutta myös harjoituksissa etenkin MPA-tasolla. Toinen merkittävä havainto tutkimuksessa oli, etteivät suositukset päivittäisen fyysisen aktiivisuuden määrästä erityisesti MVPA-tasolla välttämättä täyty jalkapalloa harrastavilla pojilla päivinä, jolloin harjoituksia ei ole. Esimerkiksi viikonloppuisin harjoituspäivinä VPA-aktiivisuuden määrä oli 61 ± 31 min, kun se päivinä ilman harjoitusta oli vain 18 ± 30 min ($p < 0,010$). Tätä voidaan pitää oleellisena perusteena lasten päivittäisen aktiivisuuden korostamiselle, myös urheilua harrastavien lasten osalta.

Asiasanat: lapset, fyysinen aktiivisuus, harjoituksia edeltävä fyysinen aktiivisuus, jalkapallo

ABBREVIATIONS

CRF = cardiorespiratory fitness

IGF-1 = insuline-like growth factor-1

IGFBP-3 = insuline-like growth factor-binding protein 3

MVPA = moderate-to-vigorous activity

PA = physical activity

PE = physical education

RPE = rating of physical exertion

SSG = small-sided soccer game

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1. INTRODUCTION

It is widely known that children's physical activity varies during the day (for example De Baere et al. 2015b, van Stralen et al. 2014 and Cox et al. 2006). In general children are more physically active outside school days and most of their moderate-to-vigorous physical activity (MVPA) is accumulated during leisure time (for example Beck et al. 2016). There's also a big variation in physical activity (PA) between children during the school days, on leisure time in week days as well as during the weekends. Boys are more active both during the week and weekends in general compared to girls (for example Hardman et al. 2009). Based on this, in studies classifications are made to divide children into high- and low-active children. The common way is to categorize children into these groups based on whether they meet PA recommendations for daily physical activity or not.

Growing majority of children around the world is not able to meet the recommended amounts of daily physical activity. Participation into organized sport has been offered as one possible solution by American Academy of Pediatrics to increase children's daily physical activity (Organized Sports for Children and Preadolescents, 2001). However, it is not guaranteed that participation into organized sport provides enough PA. This was found out by Leek et al. (2011) whose study indicated that only less than one-fourth of youth athletes in their study obtained the recommended 60 minutes of MVPA during sport practices. There has been little research on the matter, how activity is divided during the school day. One research by Fairclough et al. (2012) indicates that high active children are active during the school day as well as before it and after it. It is also unclear, how physical activity level affects the time spent performing exercise-like sustained moderate-to-vigorous physical activity (MVPA) in children. Children differ from adults in some meaningful physiological aspects concerning exercise physiology. Due to this the results from exercise physiology and physical activity studies made among adults can not be applied to children as such. Analyzing the heart rate response as well as rating of physical exertion individual's age should be taken into account.

Purpose of this study is to examine the variation of physical activity during the day in 12–13 year old boys. Purpose is also to find out whether individual's preceding physical activity on the practice day is acutely as well as in longer time scale related to the physical activity in soccer practice. Both inter-individual and individual differences are taken into account.

2. CHILDREN'S EXERCISE PHYSIOLOGY

When considering exercise physiology children are similar to adults to some extent. However, certain anatomic and functional factors differentiate children from adults during exercise. These factors are important to understand when examining children's performance in sport and in physical activities. The following chapters focus on differences between children and adults in terms of ventilation and cardiorespiratory system as well as other properties. The specific exercise physiological properties of children are also discussed.

2.1. Differences in ventilation compared to adults

Lung capacity grows with age resulting increases in ventilation capacity. According to Rowland (2005, 137–146) between the ages of 5 and 14 years, the total lung capacity changes from 1400 cm^3 to 4500 cm^3. He states that the main reason for increases in lung capacity is lungs size, which grows during age. The lung volume correlates highly with height on both boys and girls, which was discovered by Lyons and Tanner already over 50 years ago (1962). When compared to adults Rowland notes that the lung compliance in children is less and airway resistance is higher although according to him these don't change remarkably any more after age of five.

The breathing rate at rest reduces during age and in boys is found to be 24 breaths per minute at the age of 6 and 13 breaths per minute at the age of 17. Also in maximal exercise the breathing frequency reduces slowly during age being 62 breaths per minute in 6-year-old boys and 46 in 18-year-olds. (Robinson 1938 by Rowland 2015, 137–139). As compared to adults, the higher breathing frequency is needed to achieve proper minute ventilation. Evidence of core temperature's effect on breathing frequency in steady-state exercise has been seen also in children indicating that children respond to exercise in the same way as adults. (Rowland & Rimany 1995 by Rowland 2005, 145).

The oxygen consumption of children during submaximal walking and running is 10 to 30 % higher than that of adults (McArdle et al. 2015, 848). According to Rowland (2005, 143) when compared to adults children hyperventilate during exercise, which is supported by the fact that children's minute ventilation at given metabolic rate is higher at all exercise intensities (Macek et al. 1985 by Rowland 2005, 143). Even though children develop less metabolic acidosis during exercise, their ventilatory compensation is higher. The hyperventilatory response declines during age as ventilation capacity increases. The absolute value of VO_{2max} measured in liters per minute is lower in children than in adults, but does not differ remarkably when adjusted to body weight (McArdle et al. 2015).

2.2. Differences in cardiovascular system compared to adults

The size of heart grows during age increasing the absolute stroke volume. There is a close relationship of left ventricular mass with weight, height, body surface area and lean body mass, the latter one being the strongest determinant of left ventricular mass (Daniels et al. 1995). Cardiovascular responses to progressive and sustained dynamic exercise as well as on isometric contractions have similar patterns and relative magnitudes between children and adults. Therefore it can be said, that biological age does not effect the determinants of circulatory adaptations to increased muscular work. In both children and in adults peripheral factors are the main controlling determinants that increase blood circulation as a response to physical exercise's metabolic demands. These peripheral factors include especially arteriolar dilation and skeletal muscle's pumping action. (Rowland 2005, 133).

According to Rowland (2015, 116–117) heart rate in maximal exercise remains unchanged during childhood. As he states this indicates that increases in cardiac output are due to increases in heart's stroke volume. The stroke volume on the other hand depends on heart's diastolic size. Rowland continues that at given work intensity the heart rate declines during age, which indicates growth of heart size and stroke volume. He also points out that at rest the metabolic rate of young children in relation to body mass and surface area is greater than that of older children. Therefore resting heart rate declines 10 to 20 beats per minute between ages of 5 to 15 years due to both changes in basic metabolic rate and stroke volume. At the age of 5 the mean basal heart rate is about 80 bpm and at the age 15 62 bpm. After age of 10 the heart rate of girls is three to five beats per minute higher than in boys after. The myocardial contractility on the other hand is not affected by age (Rowland 2015, 116–117).

2.3. Other differences in exercise physiology compared to adults

There are evidence (Bell et al. 1980 and Baldwin 1984 by Mero et al. 2007, 44) that the division of muscle fibers is changed during age from birth to 1 year, to 6 year and to adult age. The type II C muscle fibers are encountered only in newborns and it is alleged that they are changed to slow muscle fibers by the age of 1 (Baldwin 1984). The percentage of slow muscle fibers is kept fairly stable from 1 year old onwards but the division between type II A and II B is changed between ages of 1 and 6 so that type II A become less prominent and there are equal amounts of each muscle fiber types. The amount of red blood cells and hemoglobin is increased from childhood to puberty, hemoglobin increasing from 130 g/l to 160 ± 20 g/l in boys and 140 ± 20 g/l in girls (Smith, 1977 by Mero et al. 2007, 26).

In general the hormonal levels of children are lower than those of adults. The amount of growth hormone is high in puberty having great anabolic effect. It also stimulates bone and cartilage growth, affects on carbohydrate and lipid metabolism as well as on electrolytes (Mero et al. 2007, 27–28). The level of testosterone is about 0,02 nmol/l with children but changes remarkably from age 10 onwards reaching 14–38 nmol/l in boys and 1–6 nmol/l in girls during puberty (Pelkonen & Koskimies 1984 by Mero et al. 2007). Like growth hormone, also testosterone has anabolic effect on bone growth as well as on muscle growth. It also affects on erythropoietin accelerating red blood cell development. The level of estrogen estradiol is almost zero until the age of 8–10 years. After that there's a great is increase in the amount with girls and only a small increase can be seen with boys after age of 10–12. Estradiol is mostly responsible for fat mass accumulation. (Mero et al. 2007, 28–29).

2.4. Children's special characteristics

According to McArdle et al. (2015, 858) the value of VO_{2max} in boys does not change between ages 6 and 16 being 52 ml/kg/min. In girls an evident and linear decline in VO_{2max} value is noticed between ages of 6 and 16 from about 50 ml/kg/min to 40 ml/kg/min. The decline is mostly due to changes in body composition, since girls accumulate fat mass during age and fat mass increases the energy cost of exercise but does not increase aerobic metabolism capacity. The same trend can also be seen from the absolute values of VO_{2max}, where boys start to build gap to girls from the age 12 onwards. At the age of 14 the average value of

VO_{2max} is 25% higher in boys and at the age of 16 the difference is already 50%. These differences reflect the different changes in body composition where girls accumulate more fat mass, as mentioned earlier, and boys develop more muscle mass. However, in prepubertal age the development of muscle mass is slower than in adulthood in both genders.

Endurance performance is determined by the body’s capacity to use energy efficiently. The economy of exercise enhances during age, since compared to adults children have lower ventilatory efficiency, greater body surface area-mass ratio, shorter stride length and greater stride frequency (McArdle et al. 2015, 848). Anaerobic power is lower in children than in adults and children are unable to generate high level of blood lactate during maximal effort. Reason for this might be lower intramuscular levels of the glycolytic enzyme phosphofructokinase. Brief exercise training containing MVPA in children leads to reductions in circulating insulin-like growth factor-1 (IGF-1), opposite to the effect among adults, which Scheett et al. (1999) found out in their study with 8–11 year olds. They noticed also large increases in some inflammatory cytokines, both of which are associated with catabolic states. Like they understandably stated their data suggests that: ”(…) even a relatively brief bout of vigorous exercise in healthy children initiates a hormonal response suggestive of a catabolic environment.” According to Timmons and Bar-Or (2003) rating of perceived exertion at the same relative level of VO_{2max} is higher in children than in adults. Their suggestion for this difference is that higher respiratory rate in children results in a relatively higher degree of respiratory muscle fatigue and thus resulting in a higher RPE.

2.5. Effect of exercise on children’s performance capacity

Children’s exercise physiological properties can be altered with exercise to some extent. In general physical exercise in childhood enhances the accumulation of bone mass (Beck and Snow 2003). Rowland (2005, pages 198–199) suggests it can be possible that children respond to training by similar skeletal muscle enzymatic changes as adults. Resistance training increases muscle strength both in adults and children which is seen from two different meta-analysis (Falk&Tenenbaum 1996; Payne et al. 1997). However prepubescent children have limited ability to increase muscle mass, presumably (McArdle et al. 2015) because of their relatively low androgen levels. This is also mentioned by Rowland (2005, 219) who points out in his conclusions that mechanisms in muscle strength improvement are not related to muscle size but more to other factors such as neurologic adaptations.

Anaerobic training can improve children's ability to perform short-burst activities relying mostly on anaerobic metabolism. However, it is not clear which are the factors responsible for the enhancement. It is known that children are not able to produce high amounts of lactate (for example McArdle et al. 2005, 858), so it can be asked whether anaerobic training improves children's metabolic adaptation, strength or aerobic fitness.

Endurance exercise is known to modify the muscle fiber type division towards higher proportions of slow muscle fibers and according to Baldwin (1984) it can be assumed that young child has an adaptive potential for improving both circulatory function and skeletal muscle oxidative capacity. Also Duncan and Howley (1998) address that the ability to use fatty acids instead of carbohydrates as a fuel in exercise, has been seen to develop also in children. That is, children seem to be able to oxide fatty acids on greater level of VO_{2max} after endurance training. However, children's trainability in the light of enhancement in VO_{2max} is low especially in prepubertal children, usually no more than one third of the improvements expected in adults

The size of heart grows as a response to increased amount of physical stress. As a consequence heart rate declines from birth to puberty, being 10% lower in that age with boys than with girls. In childhood physiological performance capacity is more determined by the biological age than calendar age due to differences in development status in puberty. According to Mero et al. (2007) there can be even several years difference between calendar and biological age in puberty. In general children who develop earlier do better in sports.

3. PHYSICAL ACTIVITY

Physical activity as such has got a lot of attention during recent years as work habits and leisure time activities have gone through markable change. Previously active and physically demanding work has transformed to more sedentary office work and leisure time is more and more spent watching tv or otherwise staying relatively inactive. Different kinds of activity meters and applications are developed to help people distinguish their daily routines and activity times. Also different institutions have created guidelines for physical activity time and types of activities for different age groups, which demonstrate the necessary physical activity needed to achieve the well-known health benefits being physically active has.

3.1. Measuring physical activity

Accelerometers have become the unofficial norm when assessing PA levels, like De Baere et al. (2015b) formed it. When compared to pedometers, the greatest benefit is their ability to measure the intensity of activity and not only the amount. With accelerometer it is possible to recognize whether the measured movement is done with high intensity and thus usually meaning with higher speed or with lower intensity. Together with user's physiological information the activity monitor's 3D accelerometer analyzes the frequency, intensity and regularity of user's movements and forms a picture of user's total activity. Accelerometer-based activity measurements can be qualified to different categories depending on meter properties. With Polar activity monitors for example (Polar 2016), the usual division is to specify three different categories being low, medium and high intensity. The determination of physical activity level is most commonly based on MET-value, which describes subject's energy expenditure during the activity. It is noted by WHO (2010), that vigorous-intensity activity may be 7 METs or more for children and youth while the lower limit for adults is 6 METs or more. Therefore it is important to distinguish whether the physical activity evaluation is done for children or adults. MET-value thresholds for different physical activity levels given by WHO for children and youth are listed in the table below (table 1).

TABLE 1. Physical activity level and MET-value correspondence for children and youth (WHO 2010).

Physical activity level	MET-value
Low	< 3,0
Moderate	3–6,9
Vigorous	> 7

However, Ekelund et al. (2011) noted that despite the fact that accelerometers are objective and therefore over come self-reported ways to measure PA, attention must be paid when analyzing the data they give. According to them the self-reported instruments tend to overestimate the intensity and duration of PA and sport participation. On the other hand the thresholds determined into the accelerometers play a big role when evaluating the level of PA, which is also noted by Pedišić and Batman (2015). Their concern was more related to generalization, since they admitted that accelerometers have adequate reliability for PA surveillance. Different activity meters may use different MET-value thresholds to determine the physical activity level. For example in their studies De Baere et al. (2015a and 2015b) used activity meter, that had meter's own thresholds for sedentary physical activity (≤ 1,8 MET), light physical activity (1,81–5,1 MET), moderate physical activity (5,11–7,2 MET) and vigorous physical activity (>7,2 MET). Like the researches noted these values were evaluated for the meter. Understandably it is important to consider the used thresholds for intensity levels when investigating children, since age, height and body size can be seen as influencing factors. Reilly et al. (2008) investigated the accuracy of hip worn Actigraph-accelerometer and found that at least that certain meter's output had little age- or size-related systematic variation. In another earlier research by Puyau et al. (2002) with the same, though previous model of the accelerometer and another meter called MM Actiwatch it was found that activity counts from these meters correlate highly with measured activity energy expenditure. Therefore it is justified to state that these meters are valid devices to asses children's physical activity. This indicates that accelerometers can be used as reliable measurement tool across all ages. But like Ekelund et al. (2011) pointed, more research is needed.

According to Trost et al. (2000) it is necessary to record PA data for 8 to 9 consecutive days in order to reliably estimate daily physical activity in children of age 12,9 ± 0,9 years. Both weekdays and weekend should be included in the measurements, since according to Trost et al. in the age group in question the levels of MVPA were significantly higher during weekends than during weekdays. It is also essential how long on a daily basis and at what time of the day children wear the activity monitors. Since activity periods vary during the day, Trost et al. recommended that it is necessary to monitor an entire day or sample multiple times of the day. In their study De Baere et al. (2015b) accepted measurement days having 90% compliance. Wrist-worn accelerometers are advised to wear on non-dominant hand and also user's physical information should be correct in meter's settings to ensure the most accurate activity tracking.

In their study Trost et al. (2000) used hip-worn uniaxial accelerometer that needed to be worn during wake hours and taken off during water-based activities, hence attached again. However, the technology is constantly developing easing the measurement tool usage. For example more and more meters are becoming water proof and can be worn in the wrist instead of hip. There has been little research on wrist-worn accelerometers with children. The general deficit of these meters is that they do not record activity during activities where the hand holding the meter is kept fairly stable, such as cycling. It is also argued that meters are not suited for children due to their prediction algorithms which are developed for adults. The first subject is true no matter who the meter user is. One possible solution for this is to use GPS-technology in activity meters to record physical activity in activities where meter's accelerometer can not be reliably used. The latter subject is something that meter developers can influence. Designing calculation algorithms that take into account whether the user is a child or an adult would make the data more reliable. Aibar and Chanal (2015) studied how the epoch length in PA measuring affects the measurement results in means of different physical activity intensities with children. They found that longer epochs correlated with higher levels of light, moderate and moderate-to-vigorous physical activity as well as lower levels of sedentary time and vigorous physical activity. According to them shorter epochs from 1s to 5s should be therefore used to measure physical activity in children to avoid measurement errors.

To writer’s knowledge no previous studies have used activity meters to record activity during soccer practice with 12 year old boys. As such the activity measured by the meter corresponds quite well the physical activity during soccer. So it is justified to compare the activity meter - measured daily activity and activity during soccer with each other.

3.1.1. Self-reported and objectively measured physical activity

Already Epstein et al. (1996) reported based on their study that predictors of activity level with children are different depending on the measurement method used. According to them, this was consistent with previous study findings among adults. The results of Epstein et al. show that with children the self-reported activity is significantly greater compared to objectively measured activity.

Later in her study Heidi Syväoja (2014) studied also the differences between self-reported and activity meter measured physical activity among children and what kind of influence physical activity measured on these two different ways has on academic performance. Subjects in her study were children from five schools in the Jyväskylä school district in Finland, mean age 12,2 years and total amount 277. The question used in Syväoja’s study was: ”Over the past 7 days, on how many days were you physically active for total of least 60 minutes per day?” The response categories were 1 day, 2 days, … 7 days. The same question was used earlier in a study focusing on school-aged children’s health behavior performed by WHO (HSBC). There was a short description before the question describing what kind of physical activity should be taken into account. Also examples of possible activities were listed, including running, walking quickly, rollerblading, biking, dancing, skateboarding, swimming, snowboarding, cross-country skiing, soccer, basketball and Finnish baseball. Syväoja found inconsistent results indicating that self-reported and objectively measured physical activity are not equal. She speculated that differences may be due to measurement tools’ inability to reliably measure some of the activities that are reported in questionnaires, such as swimming, cycling and skateboarding. According to Syväoja, the test-retest agreement for self-reported MVPA has been very good (ICC = 0.82) citing Booth et al 2001 and Liu et al. 2010. Recent study of Götte et al. (2017) focused on differences between objectively measured and self-reported activity with children and adolescents. Like previous studies also they found distinctive differences between these two measurement types and based on results they concluded that with children objective measurements of physical activity should be preferred.

3.2. Physical activity in children

Like exercise also physical activity as such has a strong association with numerous health benefits in children, which can be seen from Janssen and LeBlanc's systematic review (2010). According to them physical activity has beneficial effects on aerobic fitness, on strength and endurance and on bone strength as well as on cardiovascular and mental health. The physical activity recommendations for children (2008) also emphasize the role of physical activity in building good health during school-age as well as in adult. According to them, physical activity in school-age predicts amount of physical activity in adulthood. Correlation between being fit and meeting the PA recommendations of MVPA was also found in Silva et al.'s (2013) study. Ara et al. (2004) studied the effect of outside school PA on physical fitness with 8–11 year old boys. According to their assumptions they found that boys participating in an additional at least 3 hours per week physical activity outside school had better physical fitness than the control group, which participated only in the compulsory physical education (PE) sessions. In their study the more physically active boys had significantly better aerobic fitness, anaerobic capacity, running speed and lower-extremity muscle power production. It is shown by many studies that in general boys are more active than girls and spend less time sedentary. Cooper et al. (2015) examined The International Children's Accelerometry Database (ICAD) having data on children's physical activity from ten countries and 20 studies and found boys being less sedentary and more active than girls at all ages. Their results also show that from the age of age seven weight status starts to affect on physical activity level overweight or obese children being less active than their normal weight counterparts. After ages 5–6 physical activity starts to decline in all countries and with both sexes. The annual reduction in physical activity compared to that at the age of five is 3,7% in boys and 4,6% in girls (Cooper et al. 2015).

Golle et al. (2014) examined the role of sports club participation on children's physical fitness and found a strong correlation. Their results indicate that children participating in sports clubs showed better physical fitness development during four years, from age 9 to 12 regarding endurance and lower-extremity muscle strength. In another study by Silva et al. (2013) it was found that children aged 11 to 18 years taking part in organized or non-organized sport outside the school or competitive sports in a club had healthier levels of cardiorespiratory fitness (CRF) than those who did not. Especially being involved in competitive sports in a club seems to be superior to other forms and more important in ensuring healthier CRF than merely meeting the recommended MVPA level.

School plays a big role in children's PA during weekdays. For example in France more than half of their daily awaking time is spent in school (Guinhouya et al. 2009). According to van Stralen et al. (2013) European schoolchildren spent on average 65% of their school time in sedentary activities whereas only 5% was spent on MVPA. In the study of De Baere et al. (2015b) the amount of MVPA was 7% during school days. Guinhoya et al. also found correlation that at least 34 minutes of MVPA is needed during the school time in order to reach the recommended 60 minutes of daily MVPA.

Fairclough et al. (2012) found that children of the age 10-11 years accumulate most of their MVPA after school. This can be seen consistent with earlier studies by Cox et al. (2005) and Hardman et al. (2009) showing that most of children's daily steps are accumulated after school. On the contrary Guinhoya et al. (2009) found that more than 70% of children's daily MVPA is accumulated during school time. These differences may be explained with cultural differences and study design. The structure of school day may differ in New Zealand, England and in France, where these above mentioned studies took place. Data was also collected at different time of the year and amount of measured days differed.

Interestingly the study of Fairclough et al. (2012) also showed, that high active children were also more active before and during school day compared to low active children. When measuring only daily step counts and not the intensity, the same correlation was not found evident. In the study of Hardman et al. (2009) only active girls accumulated more steps during school day and leisure time compared to less active girls, whereas high and less active boys increased their daily step counts during leisure time in the same extent. Another study by Mota et al. (2008) supports this finding with girls. Their study indicates that with girls of age 10–15 years the more active group had significantly higher amounts of MVPA outside-of-school period than their less active counterparts. So in this light when measuring PA it is reasonable to focus on the intensity of activity rather than just the amount.

It is often mentioned (for example Cox et al. 2006) that the structure of a school day creates a certain ceiling for the MVPA activity time a child can accumulate and therefore differences are seen mostly on PA times out-side school. The ceiling does not, however, explain the differences in MVPA times between high and low active children during school days. It can be also argued that the time before school day is equally limited for both high and low active children even though it is not part of school day as such and therefore differences in MVPA during time before school day can be seen influenced by children's activity level too.

3.2.1. Variation during the week

It justified to think there are differences in children's activity between weekend and week days. Hardman et al. (2009) noticed that girls were more active on leisure time on week days compared to weekends and that for boys the nature of the day did not matter meaning that boys were equally active during leisure time on week days and on weekends. Findings by Fairclough et al. (2014) indicated the same trends, showing that most active boys as well as girls maintain their activity levels across week days and weekends. According to Hardman et al.'s (2009) findings their study also indicates that girls, other than the most active ones are more sedentary during the weekends and that boys' activity variation is not influenced by their activity level. So girls in general are more sedentary during weekends than boys. According to these studies girls in general took fewer steps on weekends than on week days, but boys were equally active. It was also indicated by Hardman et al. that both high-active girls and boys were more active on weekdays compared to mid- and low-active children. Also Beck et al. (2016) found children being more sedentary on weekends compared to week days. Based on these as well as on Brooke et al.'s (2016) conclusions interventions focused on PA maintenance could target all time-segments, but weekends may be particularly advantageous due to the relatively large declines observed.

3.2.2. Variation during seasons

Brusseau et al. (2012) did not find distinctive differences in PA across seasons among American Indian children from one Southwestern US American Indian community. However, children were the least active during winter months. It is noteworthy that 70% of the study sample were classified overweight. Study among British children (Hardman et al. 2009) showed higher step counts for boys but not for girls than was found in previous studies. Researchers explained this by seasonal differences and proposed that boys were more active during spring and summer. Also in the study of Brusseau et al. boys were significantly more active than girls during the summer. Another study among 8 to 11 year old British children (Goodman et al. 2013) showed that children were more physically active during longer days which had more sunlight compared to shorter ones. This was seen both on weekdays and weekend days. The higher amount of PA was mostly accumulated from out-of-home plays indicating that children took advantage the higher amount of day light by playing outside. PA accumulated from organized sport and active travel were not affected by the time of the year.

3.2.3. Role of motivation in physical activity

Markland and Tobin (2004) developed a form called BREQ-2 from the basis of original BREQ (Behavioral Regulation in Exercise Questionnaire) assessment by Mullan et al. (1997). The modified BREQ-2 form took in count also amotivational factors. This form was used in a study among 10–12 year olds by Seghers et al. (2014) to assess how children's goals for leisure-time sport and PA predict physical activity. With the form they studied the motivation for being physically active. Motivation can be divided into two parts: autonomous (identified or intrinsic motivation) and controlling motivational style (external or introjected regulation). From their study Seghers et al. concluded that pursuing intrinsic goals positively predicts autonomous motivation towards leisure-time sport and PA. Furthermore they said that social agents (PE teachers, coaches etc.) should be advised to stimulate children to participate in PA and sports by referring to intrinsic goals such as skill development (e.g., to learn new sports techniques) rather than by emphasizing extrinsic goals such as social recognition (e.g., it's important to win and outperform others).

The meta-analysis of Owen et al. (2014) indicated that overall levels of self-determined motivation had a weak to moderate, positive associations with physical activity (r = 0.21 to 0.31). Autonomous forms of motivation (i.e., intrinsic motivation and identified regulation) had moderate, positive associations with physical activity (r = 0.27 to 0.38), whereas controlled forms of motivation (i.e., introjection and external regulation) had weak, negative associations with physical activity (r = -0.03 to -0.17). Amotivation had a weak, negative association with physical activity (r = -0.11 to -0.21). Their conclusions were that evidence provides some support for self-determination theory tenets. However, there was substantial heterogeneity in most associations and many studies had methodological shortcomings.

3.2.4. Role of sport participation

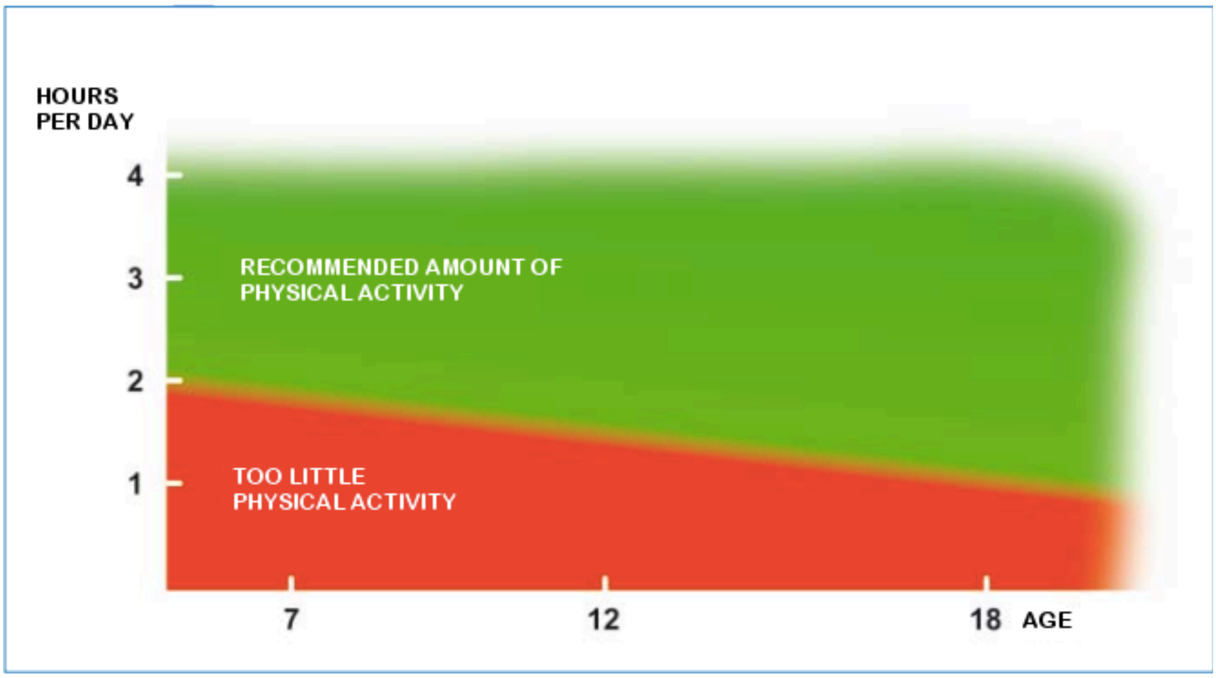
The relation of physical activity to sedentary time in adults was discussed by Craft et al. (2012). Like they brought up, there are evidence that performing sustained MVPA in exercise-like manner does not reduce the amount of time spent sedentary. In other words the amount of exercise one performs does not affect the amount of time one stays sedentary. In their study Craft et al. found support for this, their results indicating that exercise and sedentary behavior are different and independent classes of behavior. Results also showed that variations in MVPA between and within individuals are not significantly associated with time spent sedentary. Hebert et al. (2015) studied the same sort of issue with Danish children of age 7 to 10. In their study they focused on several different sports and found out that soccer participation was associated with greater overall MVPA and achievement of recommended levels of PA compared to other sports such as handball, volleyball, basketball and gymnastics. The amount of soccer participation did not seem to make a difference, since already one weekly attendance was enough to engage children into more MVPA on weekly scale and made them three times more likely to meet the PA recommendations compared to other sports. For handball the same effect was not seen until after 3 weekly participations and not at all with other sports. As the researchers noted the increased amount of PA during sport participation was not seen to be compensated with decreased amount of PA from other domains, but according to them care must be taken when analyzing the results since the study design was not optimal to study this relationship. Although the researchers do not want to make direct propositions on how soccer participation would increase children's overall amount of physical activity, it is reasonable to keep in mind when studying the relationship between PA and sport participation among children.

The opposite approach concerning role of sport participation on the total amount of PA is not studied much among children either. Nevertheless one study by Wickel and Eisenmann (2007) among 6–12 year old boys suggests that 23% of their daily MVPA is accumulated from organized youth sport. In this study the organized youth sport consisted of three different sports which were soccer, basketball and flag soccer. What was more interesting was that the increased amount of MVPA from youth sports was not maintained on days that did not include organized sport. Rather, like the researchers noted, the reduced amount of MVPA on non-sport days was replaced by low-intensity activities and in total the amount spent sedentary was higher as well. It was also pointed out that in general there were only low correlations between MVPA accumulated during unstructured activity and that from youth sport, recess and PE. Same sort of results were found in a study of O'Neill et al. (2011), who focused on 11–18 year old girls enrolling in dance classes. The researchers found that 29% of girls' total weekly MVPA was accounted from dance classes and that girls accumulated 70% more MVPA during the dance class days than on days without dance classes. It was also noted that on dance class days girls spent 8% less time sedentary compared to days that had no dance classes. From these results O'Neill et al. concluded rightfully that the additional amount of MVPA obtained on the dance class days was not maintained on the days that did not include dance classes. Still there lacks information whether the amount of MVPA during sport is affected by the total amount of PA or MVPA done acutely before sport and whether the general physical activity level has a role.

3.3. Guidelines for children

Ministry of Education and Culture in Finland published new recommendations for physical activity in early childhood in 2016. According to these guidelines children of age 8 and under should have at least three hours of physical activity daily. The activity should have variable intensities so that one hour should be spent doing vigorous activity such as playing tag, trampoline jumping, climbing, swimming and skiing. Two hours should be spent in moderate to easy activity such as hiking in the forest, biking, skating and walking, throwing and catching a ball, swinging and doing activities which need balancing.

The physical activity recommendations for older children, those between ages of 7 and 18 were published in Finland in 2008. According to these recommendations the basic advice for school-aged children is that they ”should be physically active for at least one to two hours daily, in a variety of ways suitable for each age group. Continued periods of sitting more than two hours at time should be avoided. Screen time with entertainment media should be limited to two hours per day.” (Recommendations for the physical activity in early childhood 2008). These recommendations are given more detailed to smaller age groups so that between ages 7 and 12 the daily amount of physical activity should be at least 1,5 h to 2 h and between ages 13 and 18 at least 1 h to 1,5 hours. The following picture (picture 1) illustrates these recommendations.



PICTURE 1. The physical activity guidelines for school-aged children (adopted from Recommendations for the physical activity in early childhood 2008)

In addition it is advised that at least half of the day’s physical activity is accumulated from moderate intensity physical activity done at least in 10 minutes bouts. Also vigorous intensity physical activity should be done in intervals during the day. According to given recommendations physical activity should include activities which enhance muscle strength and endurance as well as flexibility and bone health. These activities should be practiced at least three times in a week.

The Canadian Society for Exercise Physiology announced their recommendations for children between ages 5 and 17 in 2016. According to these recommendations (Canadian 24-Hour Movement Guidelines for Children and Youth 2016) children should accumulate at least 60 minutes MVPA per day involving variety of aerobic activities. In addition vigorous PA and muscle and bone strengthening activities should be done at least in 3 days per week and each day should have several hours of structured and unstructured light physical activities. Screen time is limited to two hours per day and extended periods of sitting are advised to avoid like in Finnish recommendations. The American recommendations (2008 Physical Activity Guidelines for Americans 2008) mimic those of Canadian stating that children and adolescents between 6–17 years should have at least 60 minutes of physical activity daily. According to them most of the daily activity should be moderate to vigorous intensity and vigorous-intensity PA should be done at least three times per week. Likewise these recommendations state that muscle- and bone-streghtening activities should be done at least three times per week.

4. SOCCER

Soccer is probably the most wide-spread and popular sport in the world. It is played by both genders and players at different ages. The size of the pitch as well as the amount of players with different roles on the field during the game creates differences in the amount and intensity of physical activity between players during the game. It is understandable that these differences exist also in soccer practice, although they can be altered by modifying the type of practicing. Since intensity and amount of physical activity may vary, it is also evident that the acute physiological response of soccer is altered by the training type. In the following chapters the physiological load of soccer and physical activity during soccer practice as well as measuring it is discussed.

4.1. Physiological load of soccer

Long term soccer practice is known to increase bone health in prepubertal boys (for example Seabra et al. 2012 and Zouch et al 2008) and in different pubertal stages (Nebigh et al. 2009) in regards of bone mineral density. According to Nebigh et al.'s research pubescent soccer players had significantly higher hormonal concentrations of GH, IGF-1 and IGFBP-3 than their counterparts and that bone mineral density was highly correlated with these hormones.

The acute physiological effect of soccer practice depends highly on the training type used. Morgans et al. (2014) summarize different types of training drills and small-sided games (SSG) used in soccer practice. Notable on each of them is that the heart rate during active play is near the anaerobic threshold, slightly below or above it. Like Morgans et al. state the development of aerobic and anaerobic systems is vital, since these metabolic systems are important in soccer. The vast use of SSG is discussed profoundly in Aguiar et al.'s (2012) review. They point out the ability to modify meaningful factors in SSG in order to change the acute physiological response. One study by Coutts et al. (2009) measured heart rate (%HR_{peak}), blood lactate and RPE in soccer-specific SSGs with amateur soccer players of age 20-30 years. The SSGs were performed in three 4 min bouts with 3 min recovery on various sized pitches and with various amounts of players on each side. The mean HR from the 851 individual training sessions was 87,9 ± 3,8 %HR_{peak} which corresponds with the notion from the summary of Morgans et al. being on the anaerobic threshold. The concentration of blood lactate and level of RPE on Borg's 10-scale in the same data were 5,59 ± 1,78 mmol/L and 7,0 ± 1,3 respectively. More detailed information about the physical responses to different SSG formats can be attained from the research of Brandes et al.'s (2012) with 14–15 year old boys. They measured HR and concentration of blood lactate in 3 different SSG formats being 2 vs. 2, 3 vs. 3 and 4 vs. 4. In agreement with their assumptions, game formats having less players had higher intensity compared to those with more players. The mean HR during 2 vs. 2 was 93,3 ± 4% HR_{max} and blood lactate concentration 5,5 ± 2,4 mmol/l. The same indicators for 3 vs. 3 and 4 vs. 4 SSGs were 91,5 ± 3,3 % HR_{max} and 4,3 ± 1,7 mmol/l and 89,7 ± 3,4 % HR_{max} and 4,4 ± 1,9 mmol/l respectively. The same correlation between player amount and HR and blood lactate as well as that between RPE and distance travelled at higher speeds had already been seen in earlier study by Hill-Haas et al. (2009b) with 15–16 year old boys. Like these results indicate and what was also noted by the Brandes et al. (2012) all the studied SSG formats can be classified as high-intensity exercise having HR on the anaerobic threshold.

Hill-Haas et al. (2009) examined the differences in acute physiological responses between continuous and intermittent small-sided soccer games (SSGs) with 16-year old male soccer players. The continuous SSGs consisted of 24 minutes playing without planned rest periods, whereas the intermittent SSGs had four 6-minute bouts with 90 seconds of passive rest. Both were played with 3 different formats being 2 vs. 2, 4 vs. 4 and 6 vs. 6 players. The researches did not find significant differences between continuous and intermittent SSGs for total distance covered or the distance covered with moderate intensity, but during intermittent SSGs players covered significantly longer distance at speed 13–17,9 km/h and in higher running speed in total as well as performed greater number of sprints. On the contrary during continuous SSGs the RPE and the heart rate of $\%HR_{max}$ were higher than during intermittent SSGs. These results indicate that planned rest periods during SSGs matter since players seem to play with higher intensity when the total playing time is divided into smaller bouts with recovery periods.

Another study by Alexandre et al. (2012) focused on soccer matches and training sessions among professional, youth and recreational soccer players. They found that during competitive matches the mean HR was 80–90% of HR_{max} independent of the playing level. More detailed, approximately 65% of the total match duration is spent at the intensity of 70–

90% of HR_{max} and rarely below 65% HR_{max}. They also examined the affect of playing position and stated that midfielders experience the highest exercise intensity followed by forwards and fullbacks. Also according to them the exercise intensity is reduced on the second half and may correlate with player's fitness status. Leek et al. (2011) studied PA during soccer and baseball/softball practices among two hundred children between ages 7 to 14 in California. Total practice times for soccer ranged from 40 to 130 minutes. According to their results boys spent nearly 60% of practice time doing MVPA, which corresponded nearly 60 minutes in time. However, the amount of sedentary time was almost 28% and light PA close to 20%, which corresponded 29 minutes and 20 minutes respectively.

4.2. Measuring training load in soccer practice

Heart rate is a common way to measure training load in many sports and according to Morgans et al. (2014) is widely used in soccer too. Another way to measure training load in soccer is to use GPS data, which gives detailed information about the distance covered and the intensity of movement. However, like Brandes et al. (2012) pointed out, the total distance covered is not a prober way of measuring training load at least in practices with small-sided games (SSGs), since the distance covered reduces but the intensity increases when less players are on the field in SSGs. Therefore combining both the HR and GPS data gives more detailed information about training load in soccer and Morgans et al. says it has become more and more frequent assessment method in recent years. According to Morgans et al. also the use of RPE scales have been common in soccer, which is justified with the results by Coutts et al. (2009) who found it to be valid indicator of training intensity for intermittent aerobic soccer-specific exercises.

Hill-Haas et al. (2008) examined the variability of acute physiological responses and performance profiles of 15–18 year male soccer players. They used different SSG formats with 2 vs. 2, 4 vs. 4 and 6 vs. 6 players as well as two different regimes being interval and continuos. They measured HR, RPE in Borg's 6–20 scale, blood lactate concentration and time-motion characteristics with GPS having sampling rate of 1 Hz. They found out that modifying the amount of players does not seem to affect the reliability of acute physiological responses in HR or RPE. Blood lactate on the other hand had greater variability, which has been seen also in earlier study by Rampinini et al. (2007). The test-retest variation in GPS data was also studied in the research of Hill-Haas et al. (2008). They stated that at velocities up to 6,9 km/h there was only a small variability across all SSG formats and both regimes. However, with higher velocities the variability increased despite the SSG format or regime. According to researches one possible explanation for this may be the GPS sampling rate due to which the shortest high intensity movements might not have been recorded. In general they also found that during interval SSG formats the variability in HR, RPE and time-motion measures is greater than in continuous SSGs. The reasonable explanation they gave for this is that additional rest period during interval SSGs may promote physical recovery between bouts thus resulting more lagged HR response between bouts and allowing some players to work at higher intensities. As a conclusion from these results and as researchers themselves bring out, it is reasonable to prioritize HR and RPE over external training load measures, since the variation in the mentioned internal training load measures is lower. This also supports the previously mentioned idea that HR data should be combined with GPS data and RPE would be useful too.

5. PURPOSE OF THE STUDY AND STUDY QUESTIONS

As the literature indicates, children respond to physical load differently compared to adults. Their rating of physical exertion as well as rate of ventilation is higher. In high intensity exercise children's heart rate is also higher than adults', but they are not able to produce same amounts of lactate leading to reduced capacity to work anaerobically. However, children's anaerobic performance can be enhanced by physical exercise. Soccer is probably the most popular sport in the world and different practice protocols for it has been studied widely. There is information about how physical load in soccer acutely affects children. The general principle in a protocol for small-sided game is that the intensity of physical activity reduces and distance covered increases while the amount of players increases from 2 vs. 2 games. The rating of perceived exertion is the highest with 2 vs. 2 games compared to other formats. Previous studies have focused more on soccer and boys than girls and there is information available on boys' activity on soccer practice. Also due to later pubertal age, boys are more likely to have less physiological inter-individual differences than girls. Therefore boys and soccer were also chosen for this study.

Children's physical activity varies during the day and week. It has been noticed in previous studies that children who are more active during the school day are more active through out the day. There is some evidence, that participation into organized sport does not increase individual's physical activity on days without organized sport. However, the acute effect of preceding physical activity on physical activity during organized sport remains unclear. It is not clear either, whether child's higher physical activity level makes the child more physically active in organized sport compared to child's less active counterparts.

Purpose of this study was to examine 1) whether individual's preceding physical activity during the day affects physical activity in soccer practice of the same day as well as 2) whether individual's general activity level has a correlation with the activity in soccer practice. Purpose was also to study 3) do children get the recommended amount of physical activity daily, 4) does the physical activity in soccer practice has association with children's overall physical activity and 5) is the PA in soccer practice on such intensity level that it is beneficial on children's health.

Study questions and hypothesis were the following:

1) Does the acute preceding physical activity increase, decrease or correlate at all with physical activity in soccer practice of the same day and does activity on different intensity levels matter? Previous literature does not clearly demonstrate the relationship of acute preceding activity with activity during soccer practice of the same day.

2) Are generally active individuals more or less active in practice or does it make a difference? Previous research by Craft et al. (2012) has indicated that there are no differences in physical activity in soccer practice between generally low- and high-active children.

3) Does children's measured amount and intensity of daily activity meet the physical activity recommendations for children? Based on previous research (Hebert et al. 2015, Craft et al. 2012, Wickel & Eisenmann 2007 and O'Neill et al. 2011) it is expected that children do meet the recommendations on practice days but not on days without practice.

4) Is the activity accumulated from soccer practice maintained on days without practice or does the activity from practice increase the total daily amount of activity with equal amount? Literature indicates (Wickel & Eisenmann 2007 and O'Neill et al. 2011) that activity on different levels attained from soccer practice may not be maintained on days without practice. Therefore it is assumed that the amount of physical activity on days with soccer practice is higher than the amount of physical activity on days without practice. It is also assumed that on days with practice the total amount of physical activity is increased by the amount of physical activity from soccer practice.

5) Is the physical activity during soccer practice on moderate or vigorous activity level and on which amounts? Based on previous studies (for example Hill-Haas et al. 2009 and Brandes et al. 2012) the intensity level and amount of activity during soccer practice depends on the type of practice used. It is assumed that most of the practice time is spent on moderate or vigorous intensity level.

6. METHODS

6.1. Subjects

Subjects in this study were recruited from Finnish junior soccer team JJK Juniorit Ry from Jyväskylä. All players in the team are boys and born in 2004 and the mean age at the beginning of the measurement was 12,6 ± 0,3 years. Mean height was 156,5 ± 7,5 cm and weight 47,3 ± 8 kg. Intention was to get all subjects from the team to participate in the research. Participation was voluntary and they were able to quit at any point if they wanted by informing the researcher. All subjects had their parents' approval to take part in the research. Subjects born date, weight and height were collected with questionnaire at the beginning of the measurements. 18 of total of 21 subjects returned their diary and had physical activity measurement data from the practices and their measurement data was included in the research. Therefore 86% of the recruited participants completed the measurements accordingly.

6.2. Study design

Subjects were given Polar A300 -activity meters (Polar Electro Oy, Finland), which they were advised to wear during day and night for 10 consecutive days in February 2017 from Monday to Wednesday. Subjects were told to wear the activity meter in the wrist of their non-dominant hand. Measurement was finished after 10 days and the participants were given the activity meters they wore for themselves to keep after the study. The battery of the activity meters was estimated to last for the whole study period, but subjects were advised to recharge the activity meters if necessary during night hours. When giving the activity meters the subjects were told to fill background information form (attachment 1) which includes subjective assessment of own activity. The question of subjective activity assessment was repeated in the end of the measurement.

Soccer practice data was collected from six consecutive practices during the activity data measurement period in February 2017 in Jyväskylä. First practice day was on Saturday, next three were held on Monday, Wednesday and Saturday on the following week and remaining two again on Monday and Wednesday on the week after that. 6 subjects were present in each of these practices. On average 14 (± 2) of total of 18 participants were present in every practice. Based on attendance rate the soccer practices number 2, 3, 4, 5 were selected to the analysis and 9 subjects were present in all of them. The first practice session was excluded because the subjects were given the meters on that day and it could be seen as rehearsal for their use.

The practice sessions were not strictly moderated. Three out of four practice sessions followed same sort of protocol and one included more playing than others. The protocol used in the three sessions had the first third of the time consisting of SSGs on smaller area (typically 16 x 16 m^2), with reduced number of players (4 vs. 4) and without goals or goalkeepers. The second third consisted of game episodes with actual game dimensions, goals and goalkeepers. The last third consisted of SSGs with goalkeepers and close to real-game dimensions (typically 30 x 40 m^2 and 5/6 vs. 5/6).

6.2.1. Collecting activity data

The activity meter used in this research was Polar A300 (Polar Electro Oy, Finland). The meter has 3D accelerometer which measures movements and their intensities in different directions. The meter measures heart rate with separate heart rate belt H7, which is paired with the wrist-worn meter. The information from heart rate belt to the activity meter is transferred via bluetooth. Data from the meter can be transferred via bluetooth or cable to another application. Activity monitors transferred the activity data into Polar Flow -internet service from which the activity data was collected for further analysis. The daily activity was measured based on meter’s accelerometer and informed in MET’s.

Subjects performed measurement for aerobic performance as a part of their practice season after the measurement period. The aerobic performance was measured with standard beep test and it was the first time participants performed test of this kind. The test it self was not part of this study, but results from the measurement was used as subjects’ background information. Purpose was to rank the subjects between each other according to their performance in the test and not to examine individual results as such. 16 subjects out of 18 study participants performed the beep test.

For the whole research period parents were asked to fill up diary of subjects daily activity. The diary (attachment 2) was given in paper and included predefined questions about time of wakening, start and finish of the school day, whether the school day included PE and whether the day had soccer practice. There was also a question if the subject had been ill on the day. Purpose of the diary was to provide background information about subjects daily activity to support and explain activity monitor data if needed. In the beginning of the research parents were provided an informative session about the study and how to fill up the diary.

6.2.2. Collecting data from soccer practice

In the beginning of each soccer practice subjects were asked to put on heart rate belts and to start exercise measurement with the monitor and were assisted in the usage if needed. The profile of exercise measurement was created in the activity monitors beforehand and heart rate belts are configured too so that subjects did not need to alter them. The exercise measurement profile measured HR and activity data. During the practice subject's HR and activity meter's acceleration data was used to calculate activity data and informed in MET's. The days and times of soccer practice were marked down so that those time intervals could be distinguished afterwards from the PA data. The data from soccer practice was collected from the Polar Flow -internet service in the same manner as activity data.

6.3. Analyzed variables

Activity data was collected from Polar Flow internet-service to which the data from activity monitors was transferred. In the service the activity data is informed in cumulative MET-values measured in 30 s intervals, which is calculated over the whole day. From that data daily activity time was summed up for three separate activity zones for each subject. The activity data from soccer practice was also retrieved from the service as separate values. However, it should be noted that during practice the activity is measured based on subject's heart rate and not on accelerometer. Even though two different measurement procedures was used to measure subject's activity, the activity data from soccer practice was reduced from the total daily activity data and marked down separately. From the practice time data also heart rate values were collected. Heart rate values were collected as function of time with beat by beat measurement and time spent on different heart rate zones according to subject's limit values was distinguished.

The activity measured in practice was divided into three different zones, which were light (LPA), moderate (MPA) and vigorous physical activity (VPA). From these the time spent on each zone was calculated separately. Activity on soccer practice was measured from heart rate and acceleration data and converted to MET-values. Activity data outside practices was also given in MET's measured using accelerometer's data and divided into the same three zones. The MET-value limits for different activity zones used in calculations can be seen from the next table (table 2).

TABLE 2. Limit values for activity zones in MET-values.

Activity zone	MET-value
Light physical activity (LPA)	1,8 – 3,5
Moderate physical activity (MPA)	> 3,5 – 6
Vigorous physical activity (VPA)	> 6

6.4. Statistical analysis

Statistical calculations were made with Apple iWork Numbers version 4.1 and with IBM SPSS Statistics version 24. The data is presented as averages and standard deviations for the entire study group as well as for two separate subgroups. In most cases the data is presented separately for weekdays and weekend days. The data was normally distributed according to Shapiro-Wilk analysis and parametric tests were used to analyze the data. The differences between amounts of activity in different activity levels were analyzed with paired or unpaired t-tests depending on the situation. T-tests whit multiple comparisons between groups were corrected using Bonferroni procedure. Pearson's Correlation was used in the correlation calculations for separate practice sessions (results shown in tables 5 through 8) and Spearman's correlation was used when calculating practice session correlations with average values (results shown in table 4).

Acute activity preceding and after practice on the same day was collected from each subject's activity data separately based on timestamp when the practice was started and finished. Therefore the actual time from which the acute activity was calculated varied a bit between subjects. This enabled precise individual analysis of the time spent active immediately before and after practice.

7. RESULTS

As seen from the figure below (figure 1) the subjects had on average 186 ± 44 minutes of daily light physical activity, 66 ± 23 minutes of moderate physical activity and 38 ± 14 minutes of vigorous physical activity on daily basis during weekdays. Possible practice time physical activity is included in these figures. Differences in the amounts of activity on different activity levels were significant between all activity levels.

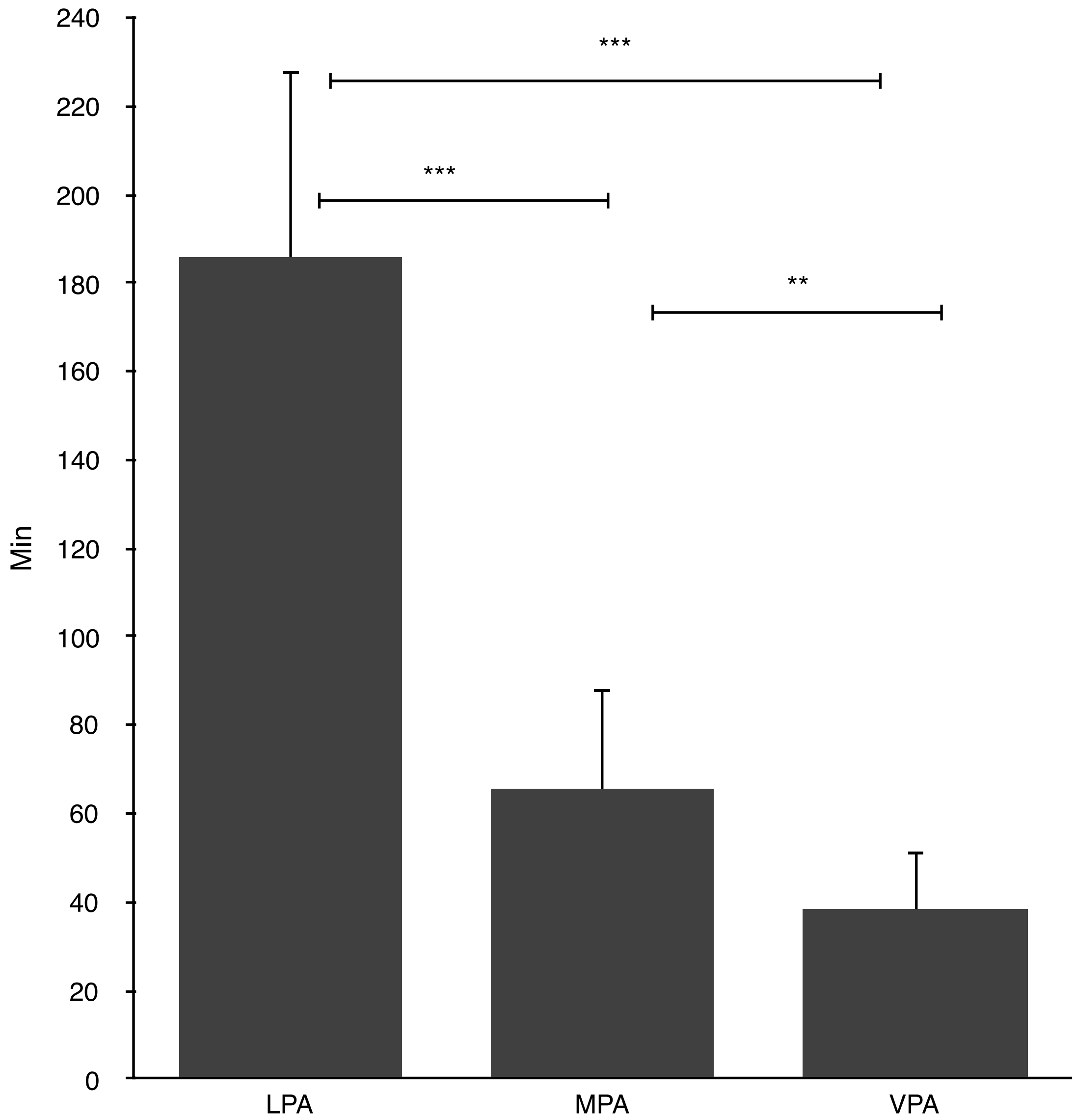


FIGURE 1. Averages of daily physical activity on different PA levels during weekdays in minutes, practice time physical activity included, *** indicates significant difference ($p \leq 0{,}001$), ** indicates significant difference on level $p < 0{,}010$ and vertical bar shows standard deviation.

During weekend days the amounts of daily physical activity were 139 ± 62 minutes, 44 ± 28 minutes and 34 ± 25 minutes respectively as represented in the next figure (figure 2). Differences in the amounts of activity on different activity levels were significant between light and moderate activity level.

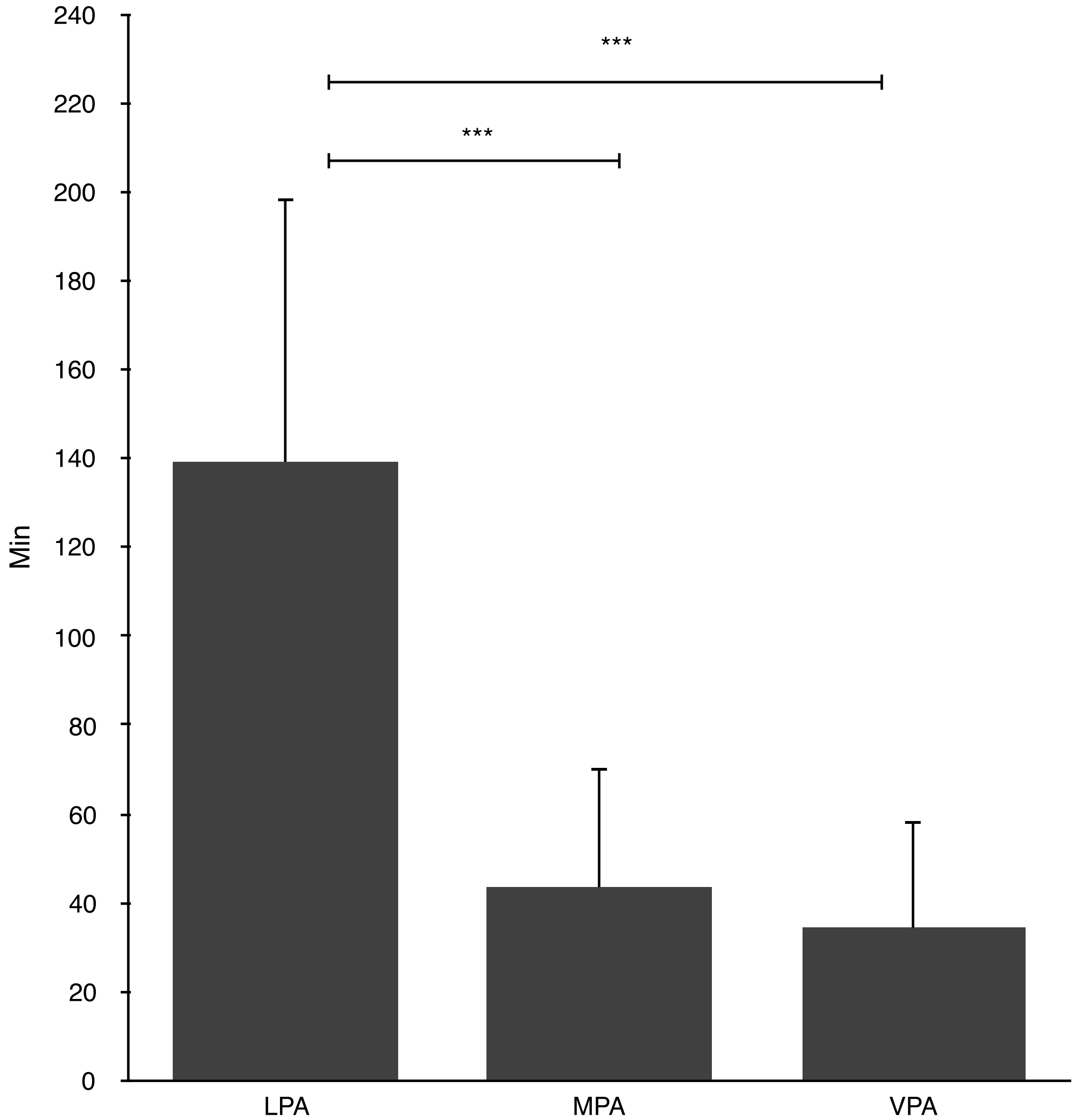


FIGURE 2. Averages of daily physical activity on different PA levels during weekend days in minutes, practice time physical activity included, *** indicates significant difference ($p < 0,001$).

However, the inter individual differences were big the least active subject having on average 38 ± 30 minutes of MVPA in a day during weekdays and the most active subject having on average 138 ± 41 minutes of MVPA in a day. During weekend days the least active subject had on average 1 ± 0 minute of MVPA and most active subject 143 ± 42 minutes. The variance between days was can be seen from the standard deviations between subjects in the average activity time. On weekdays the standard deviation ranged from 19 to 73 minutes and on weekend days from 0 to 64 minutes. The next figure (figure 3) shows subjects' order based on daily MVPA on weekdays and weekend days, including practice time physical activity. In the same figure is included subjects order based on beep test performed after the measurement period. The beep test gives indications of subject's aerobic fitness and order number in the figure illustrates subject's performance in the test and aerobic fitness compared to other participants in the study. For example subject with id 9 was the most active in the study group on weekdays and weekend days and had the highest result in the aerobic performance test whereas subject with id 17 was the third most active on weekdays and seventh least active on weekend days, but had the third best result in the aerobic performance test.

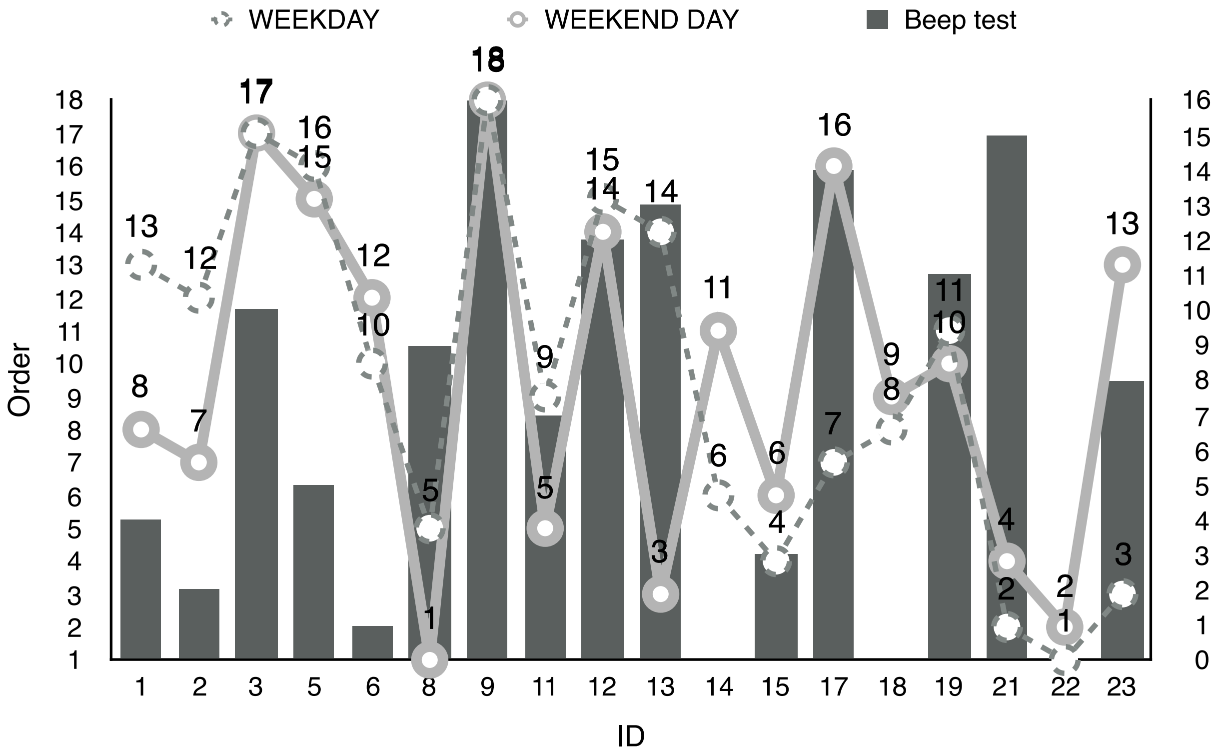


FIGURE 3. Subjects' order on weekdays and weekend days based on daily average MVPA time (lines and numbers) and order based on performance in beep test (bars). In MVPA order number 18 represents the most active subject and in beep test order number 16 represents the best performance.

Subjects were divided into upper (N = 9) and lower half (N = 9) based on their average time on moderate to vigorous activity zone during the whole measurement period, weekday and weekend day as well as practice time activity taken into account. Comparing week day and weekend day total physical activity between most and least active children shows that the most active half of the group was more active than the other half of the group on both types of days. As seen from the next figure (figure 4), in both cases the difference was significant. Also illustrated in the next figure is the difference between weekdays and weekend days for the different subgroups. In both groups, the difference in the average amount of daily PA was significant between weekdays and weekend days.

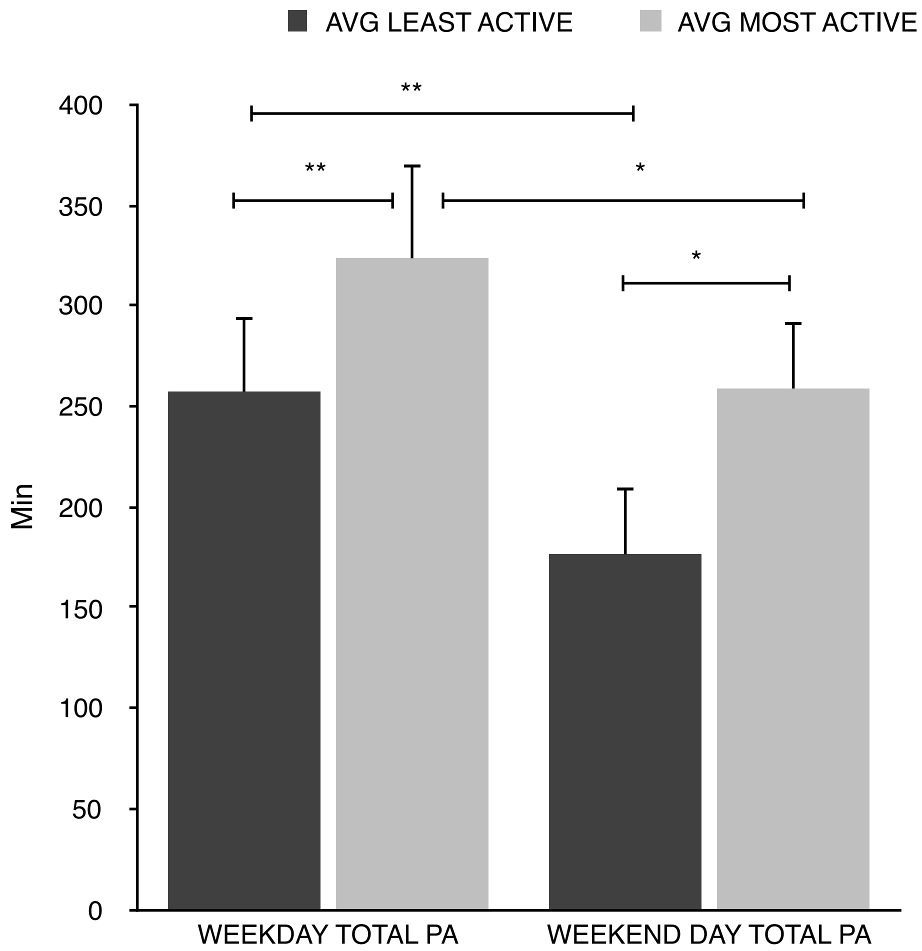


FIGURE 4. Averages of total daily physical activity for groups of least (N = 9) and most active subjects (N = 9) in minutes, separately for weekdays and weekend days, practice time physical activity included, * indicates significant difference on level $p < 0,05$ and ** indicates significant difference on level $p < 0,010$.

Next figures show results between the most and least active children for average daily activity separately for weekdays (figure 5) and weekend days (figure 6) when possible practice time activity is included. As seen from the results, most active half of the study group had significantly more moderate physical activity compared to least active half during weekdays. The same significant difference was present also on weekend days.

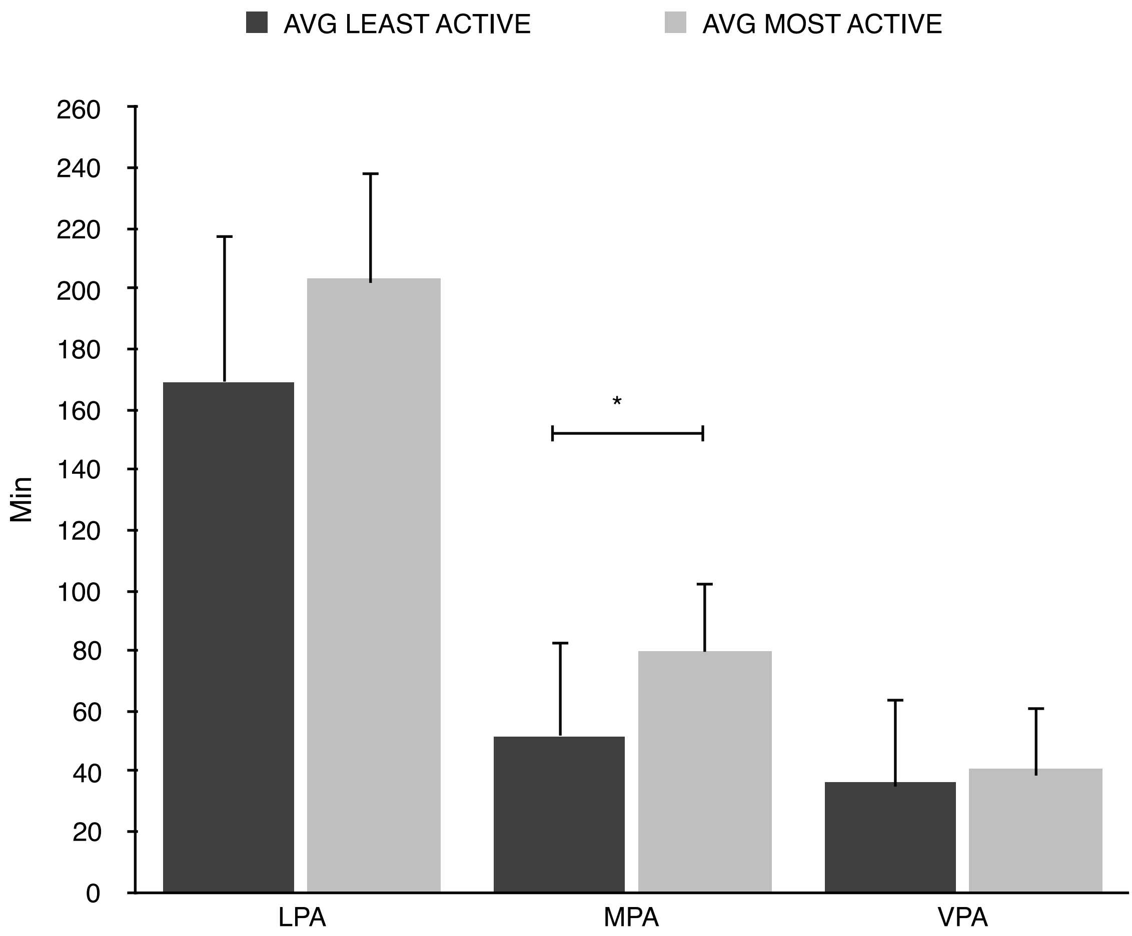


FIGURE 5. Averages of daily physical activity on different PA levels during week days for groups of least (N = 9) and most active subjects (N = 9) in minutes, practice time physical activity included, * indicates significant difference (p < 0,05).

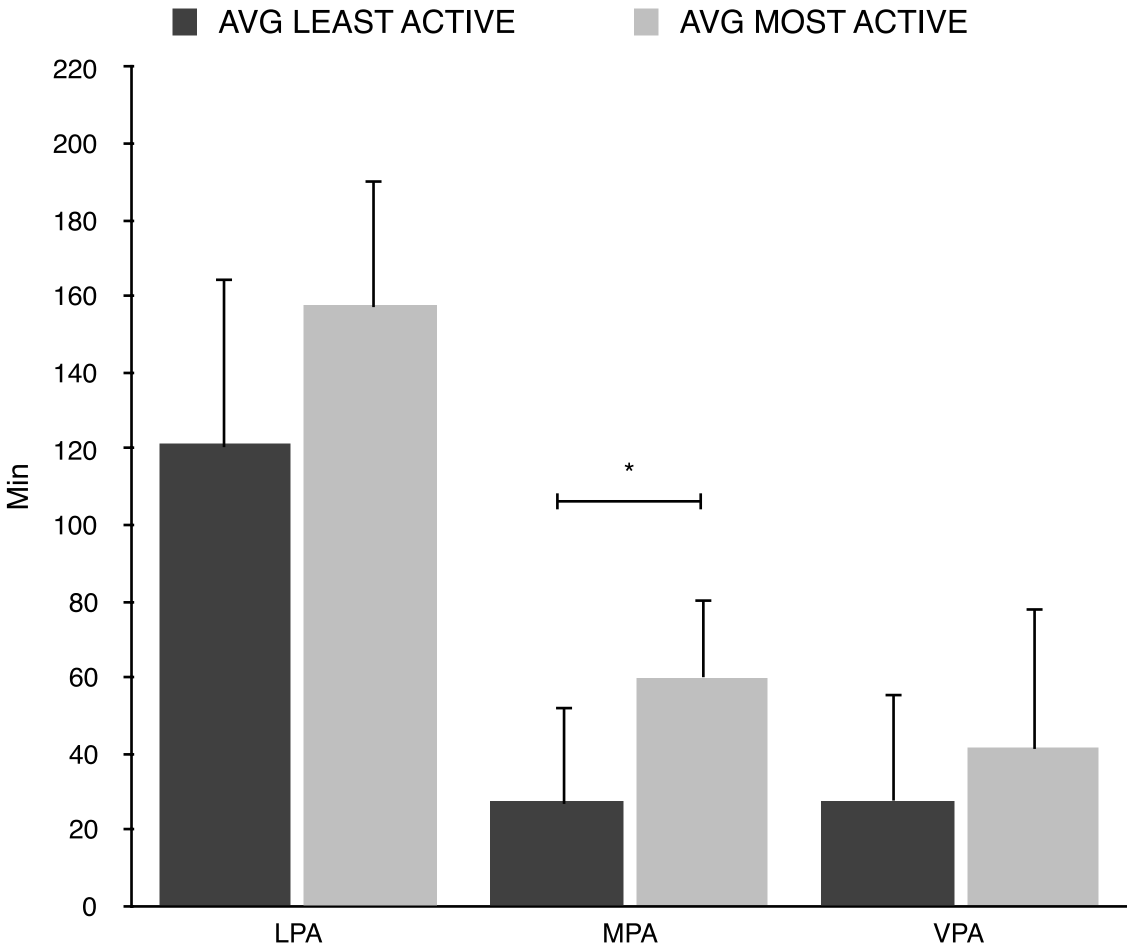


FIGURE 6. Averages of daily physical activity on different PA levels during weekend days for groups of least (N = 9) and most active subjects (N = 9) in minutes, practice time physical activity included, * indicates significant difference ($p < 0,05$).

In the diaries subjects were asked to evaluate on how many days during past 7 days they had been active at least 60 minutes on moderate to vigorous intensity level. Comparing their answers to measurement data showed that 2 subjects reported the same amount of MVPA days as the measurement data indicated. 5 subjects reported having more activity days than the measurement data indicated and 6 subjects reported having less activity days than the measurement data indicated.

Daily time at wake during weekdays was 15 h 3 min ± 32 min and during weekend days 13 h 35 min ± 50 min according to subjects' self-reported diary. The total time of awake time spent active was 32% on week days and 27% on weekend days. Time on different PA levels and their percentage of awake time can be seen on next figures separately for weekdays (figure 7) and weekend (figure 8) days.

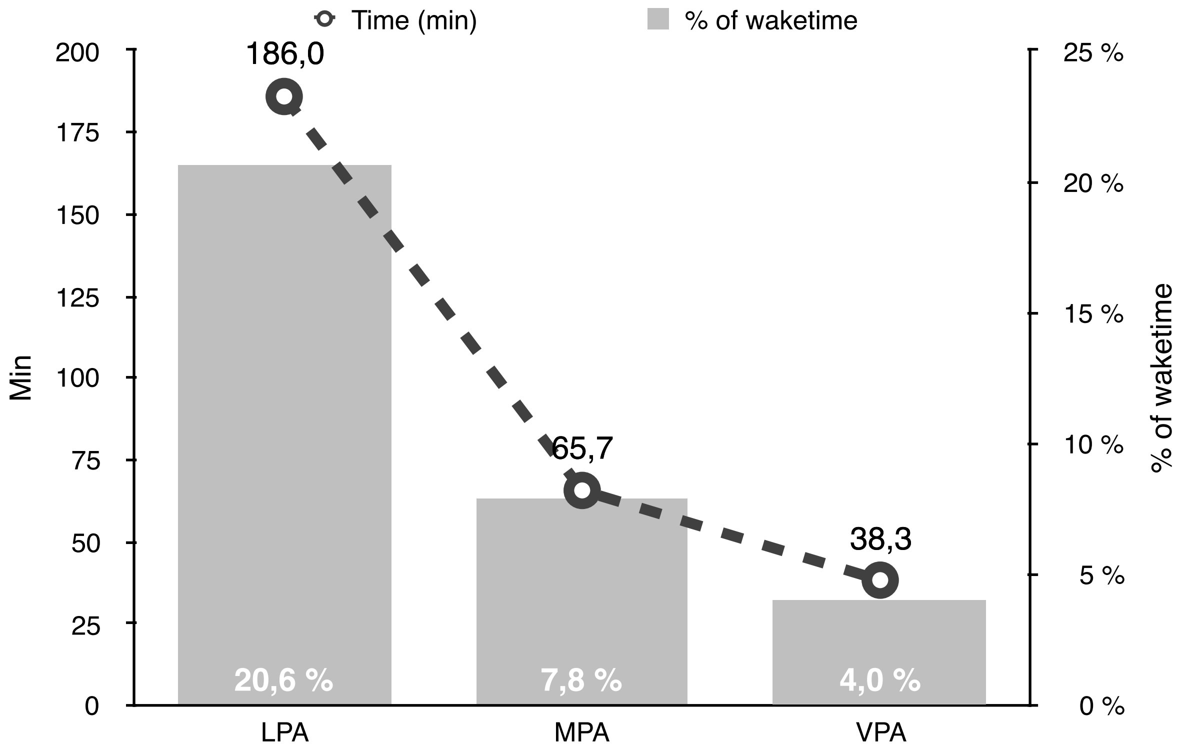


FIGURE 7. Average time on different PA levels in minutes and their percentage of total awake time during weekdays.

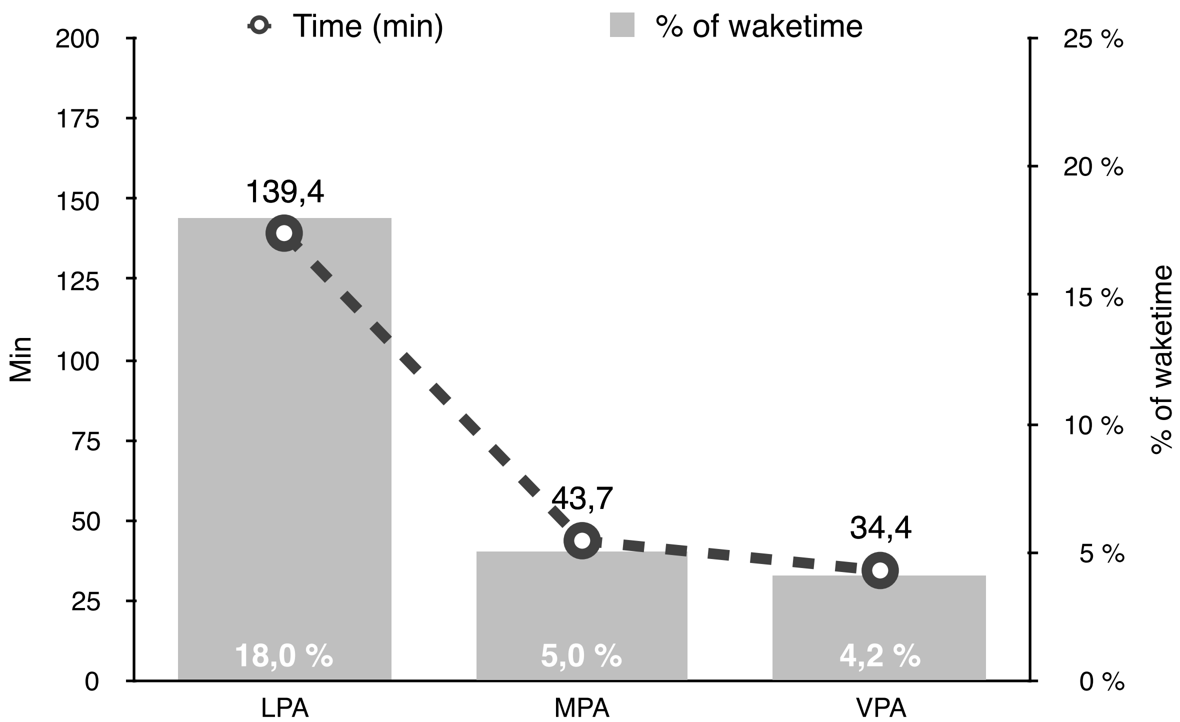


FIGURE 8. Average time on different PA levels in minutes and their percentage of total awake time during weekend days.

Results comparing activity between days with and without practices can be seen in next figures. The first one (figure 9) illustrates average amount of PA at different levels on weekdays and second one (figure 10) shows that from weekend days. On weekdays there were significant difference between days with and without practice on moderate physical activity level as well as on vigorous physical activity level. On weekend days, significant difference between days with and without practice was found on vigorous physical activity level.

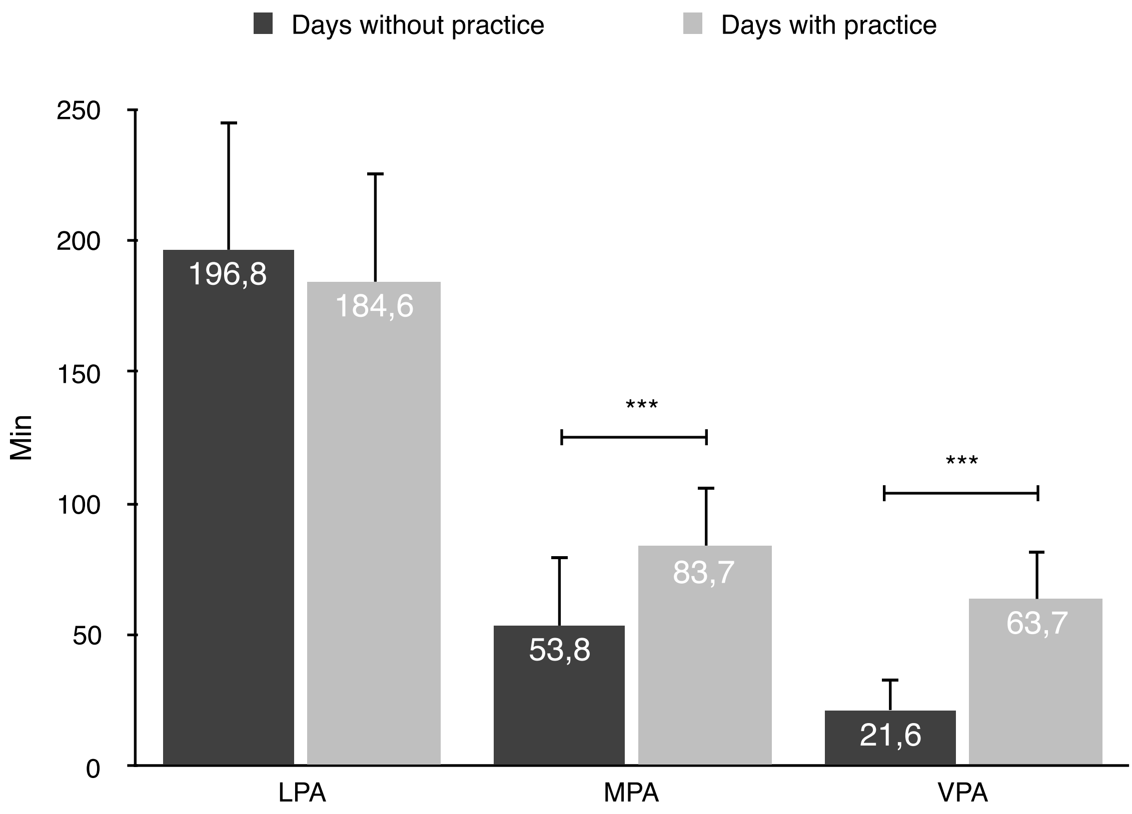


FIGURE 9. Average PA time on different levels on weekdays with and without practices in minutes, *** indicates significant difference (p < 0,001).

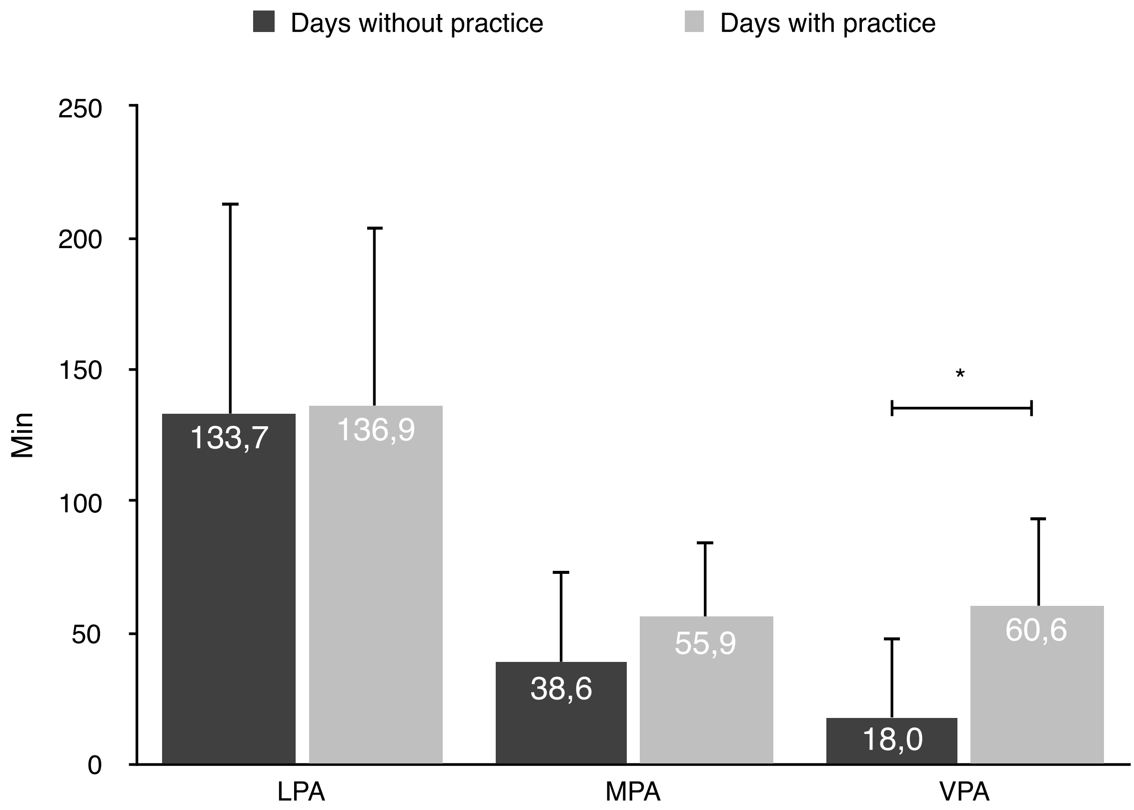


FIGURE 10. Average PA time on different levels on weekend days with and without practices in minutes, * indicates significant difference (p < 0,05).

During practice subjects spent on average 6,1 ± 5,8 minutes on light physical activity level, 35,6 ± 5,9 minutes on moderate physical activity level and 47,0 ± 6,0 minutes on vigorous physical activity level during single practice session. Individual averages of times spent at different activity levels during practice can be seen from the next table (table 3). Depending on the subject, the average time is calculated from one to four practices. The table shows the inter individual differences on different PA levels during practices.

TABLE 3. Individual one to four practice averages of times spent at different physical activity levels during practice.

Subject	LPA (min)	STDEV	MPA (min)	STDEV	VPA (min)	STDEV
1	4,1	2,4	41,0	12,1	48,4	10,2
2	21,4	6,4	38,9	20,1	36,3	9,2
3	10,8	3,2	22,0	11,3	8,0	7,8
5	10,7	7,1	35,9	8,1	20,4	4,2
6	4,0	2,5	61,8	15,3	27,8	14,0
8	6,5	4,1	26,5	2,0	31,4	8,5
9	4,5	3,1	30,5	11,5	54,0	17,8
11	7,7	2,8	33,3	17,7	26,4	5,4
12	4,9	3,2	36,6	10,1	47,8	14,9
13	0,7	0,8	17,1	7,1	49,1	14,8
14	0,7	0,6	19,0	8,6	47,0	18,6
15	5,4	2,5	34,5	11,7	49,5	6,5
17	2,9	2,3	33,5	10,1	52,1	13,3
18	1,5	2,0	18,6	3,8	59,0	12,3
19	4,5	2,6	28,3	8,3	58,4	6,7
21	10,0	NA	10,8	NA	8,1	NA
22	11,0	NA	10,9	NA	12,3	NA
23	6,7	1,8	18,5	1,2	39,9	9,1

Figure 11 shows average practice time physical activity on different activity levels between groups of most and least active participants. There were no significant differences between groups on any activity level during practices.

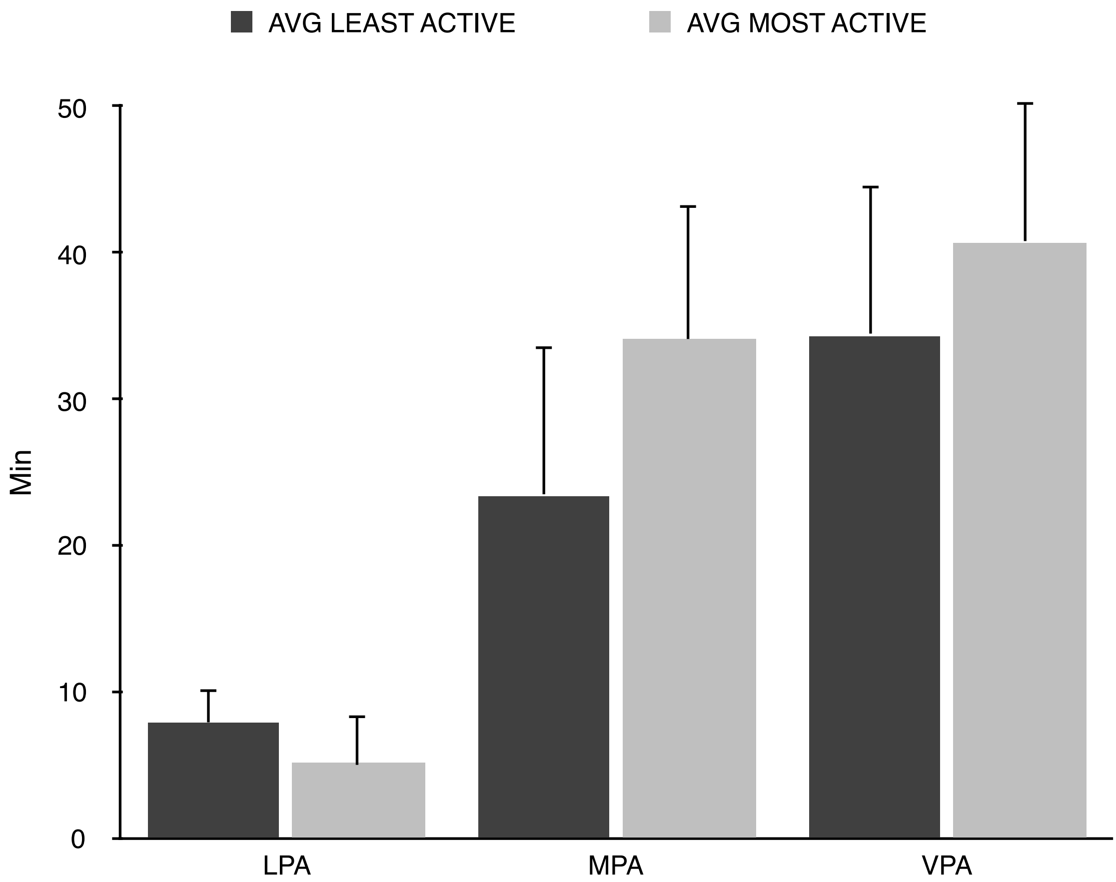


FIGURE 11. Practice time activity on different activity levels separately in minutes for most (N = 9) and least active subjects (N = 9).

The correlation of subjects' acute activity of the same day on different physical activity levels with physical activity on different levels in practices is shown in following table (table 4) calculated with average values. The next tables (table 5 – table 8) give the same correlation numbers separately for each practice session. As seen from the tables, acute preceding activity on several levels has significant positive correlation with different activity levels during practices when individual practices are examined separately, but not when correlation is calculated with average values. In individual practice sessions the strongest correlation between preceding physical activity on the same day and practice time physical activity is found between preceding light activity on the same day and moderate activity during practices on each practice day (day 1 $r = 0,650$, $p = 0,001$; day 2 $r = 0,834$, $p < 0,001$; day 3 $r = 0,837$, $p < 0,001$ and day 4 $r = 0,808$, $p < 0,001$). Participants in the practices varied a little, but in total 15 out of 18 subjects were present in the practices on day one and four and 14 subjects were present in the practices on day two and three.

TABLE 4. Correlation coefficients (r) between PA levels during practices and total amount of physical activity before practice on the same day, calculated with average values from four practice days.

	LPA before	MPA before	VPA before
LPA practice	r = 0,067, p = 0,791	r = -0,092, p = 0,717	r = -0,312, p = 0,208
MPA practice	r = 0,199, p = 0,428	r = -0,222, p = 0,376	r = -0,189, p = 0,453
VPA practice	r = 0,001, p = 0,997	r = 0,222, p = 0,376	r = 0,214, p = 0,395

TABLE 5. Correlation coefficients (r) between PA levels during practices and total amount of physical activity before practice on the same day, practice day 1, significant values shown in bold.

	LPA before	MPA before	VPA before
LPA practice	r = 0,271, p = 0,235	r = 0,124, p = 0,593	r = 0,365, p = 0,104
MPA practice	**r = 0,650, p = 0,001**	**r = 0,485, p = 0,026**	**r = 0,462, p = 0,035**
VPA practice	**r = 0,470, p = 0,032**	**r = 0,485, p = 0,026**	**r = 0,571, p = 0,007**

TABLE 6. Correlation coefficients (r) between PA levels during practices and total amount of physical activity before practice on the same day, practice day 2, significant values shown in bold.

	LPA before	MPA before	VPA before
LPA practice	**r = 0,555, p = 0,009**	r = 0,329, p = 0,145	r = 0,341, p = 0,130
MPA practice	**r = 0,834, p = 0,000**	**r = 0,511, p = 0,018**	**r = 0,552, p = 0,010**
VPA practice	**r = 0,731, p = 0,000**	**r = 0,786, p = 0,000**	**r = 0,535, p = 0,013**

TABLE 7. Correlation coefficients (r) between PA levels during practices and total amount of physical activity before practice on the same day, practice day 3, significant values shown in bold.

	LPA before	MPA before	VPA before
LPA practice	**r = 0,482, p = 0,027**	r = 0,413, p = 0,162	**r = 0,557, p = 0,009**
MPA practice	**r = 0,837, p = 0,000**	**r = 0,542, p = 0,011**	**r = 0,781, p = 0,000**
VPA practice	**r = 0,668, p = 0,001**	**r = 0,539, p = 0,012**	**r = 0,470, p = 0,032**

TABLE 8. Correlation coefficients (r) between PA levels during practices and total amount of physical activity before practice on the same day, practice day 4, significant values shown in bold.

	LPA before	MPA before	VPA before
LPA practice	**r = 0,561, p = 0,008**	**r = 0,620, p = 0,003**	**r = 0,476, p = 0,029**
MPA practice	**r = 0,808, p = 0,000**	**r = 0,537, p = 0,012**	**r = 0,445, p = 0,043**
VPA practice	**r = 0,780, p = 0,000**	**r = 0,570, p = 0,007**	r = 0,364, p = 0,105

8. DISCUSSION

Purpose of this research was to study the relationship of acute preceding physical activity with the activity during soccer practice of the same day with children. Purpose was also to examine the total daily amount of PA, what is the amount of PA on days without practice compared to days with practice and is the PA during soccer practice on such intensity level that it is beneficial to children's health. The main findings of the present study were 1) previous PA of the same day before soccer practice has positive correlation with PA during soccer practice at several different activity levels when practice sessions are examined individually, 2) even children engaged in sports have difficulties to achieve the recommended amount of daily PA, especially during weekends and 3) the PA attained on practice days is not maintained on days without practice.

Acute preceding activity and general activity level. Main purpose of this study was to find out, whether individual's preceding physical activity on the same day affects physical activity in soccer practice of the same day. Previous studies did not indicate whether there would be any correlation or not. As the correlation numbers separately for each practice day and different physical activity levels show, there were significant correlations on different activity levels between acute preceding activity on the same day and activity during practices. The highest associations were between preceding light physical activity and moderate physical activity during practice in each practice session. According to results subject's daily amount of activity before soccer practice seems to have a relationship with the amount of physical activity in soccer practice on several physical activity levels. However, in addition to the strongest correlation numbers between equal activity classes from different practice sessions, no other patterns were easily recognized. Results suggest that acute light physical activity may lead to increased physical activity on the moderate activity level during practices. So being physically active at light activity level before the practice on the same day may promote more moderate physical activity in practices. As seen also from the correlation coefficients for individual practice sessions, no negative correlations were found. This suggests that preceding physical activity on any level does not reduce the activity in soccer practice. Or interpreted from opposite view point: soccer practice participation is not associated with reduction of the physical activity before the practice on the same day. If the four different practice days were handled together and the average amount of acute preceding PA from four days was compared with the average amount of PA during four practice sessions, no significant correlations were found. This makes worth questioning, how should the four different practice days and their measurement data be interpreted. Is it reasonable to calculate the average values from these days at all, since each of the day and practice is different?

Another purpose was to find out are generally more active children also more active during practices. Based on previous research (Craft et al. 2012) it was assumed that there are no differences in physical activity during soccer practice between low- and high-active children. Even though the results indicate that high-active children in the study group had more moderate and vigorous physical activity time during practices compared to the least active half of the study group, these differences were not significant. On the contrary, less-active half of the study group had more light physical activity during practices compared to high-active participants, but this difference was not significant either. Therefore, as no significant differences were found, the original hypothesis that no differences between high- and low-active children would not be found proved to be accurate.

Daily amount of physical activity. In the light of the Finnish recommendations for children's daily physical activity (2008) the results of this study seem good. In the recommendations it is noted that children in the age of 12 should be physically active at least 1,5 hours to 2 hours daily and for 13 year olds the recommended amount is at least 1 hour to 1,5 hours. The intensity of physical activity is important, since according to the recommendations at least half of the activity should be in the moderate intensity level and also vigorous physical activity should be included. This means at least 45 minutes to 1 hour of daily moderate physical activity for 12 year olds and 30 minutes to 45 minutes for 13 year olds. In the beginning of the measurement period participants' average age was 12,6 ± 0,3 years, some of the participants had turned 13 and most were 12 year old. So the average amount of over 1 hour of moderate physical activity for weekdays and 45 minutes for weekend days that can be seen from the results covers the recommendations for both 12 and 13 year olds. Also based on previous study (Hebert et al. 2015) it was somewhat expected that children engaged in soccer are likely to meet the physical guideline for MVPA. However, it is noteworthy that on weekdays only two subjects had the average amount of moderate physical activity below 45 minutes and on weekend days there were 9 subjects who did not reach this recommended amount. As previous studies (Beck et al. 2016, Brooke et al. 2016) have underlined attention should be paid on children's physical activity especially on weekends.

As seen from the results, most of children's daily physical activity was at light level. This was true both for weekdays and weekend days. The average amount of light physical activity was higher on weekdays than on weekend days, since on weekdays children accumulated on average 3 hours of light physical activity and on weekend days the amount was about 2,3 hours. Same sort of difference between weekdays and weekend days can be seen from the average daily amount of moderate physical activity. During the week children had on average 1 hour of moderate physical activity in a day whereas during weekends the daily amount was less than 45 minutes. Previous studies by Hardman et al. (2009), Fairclough et al. (2014) and Beck et al. (2016) have reported children being more sedentary during weekend days when compared to weekdays which can also be seen in the results. In these previous studies, however, it is also mentioned that the type of day did not matter in the case of boys or in the case of high-active children. Even though in this study children are found to be more sedentary during the weekend days, these results are not supported by the previous studies mentioned above, since all the participants in this study were boys. Also, it can be seen from the results, that the most active half of the study group was significantly more active during the weekdays compared to weekend days. Therefore the finding from previous studies indicating that type of day did not matter in the case of high-active children was not supported by this study. But it should be mentioned though, that in the results of this study the participants were divided into two groups representing the most and the least active half of the study group and not high- or low-active children in general level. In most studies (for example Fairclough et al. 2012 and Hardman et al. 2009) children are usually categorized high- and low-active based on whether they meet the recommendations for physical activity or not. In this study most participants (17 on weekdays and 12 on weekend days) accumulated the amount of MVPA given in the physical activity recommendations and thus division into high- and low -active children based on achieving the amount of PA given in PA recommendations would have not been reasonable. Therefore even the least active half of this study group is not necessary low-active in the same manner as may be determined in other studies.

On the other hand the daily amount of vigorous physical activity was almost equal between days of week and weekend. It should be noted though, that the amount of variance between subjects was the largest and differed the most between weekdays and weekend days in vigorous activity level when taken into account the actual average numbers as well. For light physical activity the standard deviation was 44 minutes on weekdays and 62 minutes for weekend days, the total amounts of activity being 186 minutes and 140 respectively. For moderate physical activity the deviation numbers were 23 minutes and 28 minutes and total activity numbers 66 minutes and 44 minutes respectively. For vigorous physical activity the standard deviation was 14 minutes out of 38 minutes of activity for weekdays and 25 minutes out of 34 minutes for weekend days. This indicates that although children on average spent equal times on vigorous physical activity level during the weekdays and weekend days, during weekend days there were more children who had high amounts and children who had low amounts of vigorous physical activity than on weekdays. And the same numbers also indicate that when compared to other levels of physical activity more children had higher and lower amounts of vigorous physical activity on weekend days than other levels of physical activity.

Results showing children's order in the study group based on their MVPA on weekdays and weekend days illustrate how the activity varies for one individual. From the results it can be seen that compared to others the most and least active subjects were equally active during week and weekend days, but that for other subjects the order in the group varied. Interestingly also seen from the results is that the physical activity level and fitness level do not necessarily always go together. The results show, how performing well in the beep test compared to others in the group does not mean being also among the most active subjects in the group. Since these results are calculated within the group it should be kept in mind though, that the order of one individual is affected by others' performance. Subject's biological age was not measured or taken into account in this study, but it could be discussed would it affect subject's activity level. Like literature shows (for example Rowland 2005, 137–146; McArdle et al. 2015, 848 and Timmons & Bar-Or 2003) children's anaerobic power enhances during age and biological development affects many physiological features relevant for PA, like muscle mass and lung capacity. Therefore it is reasonable to consider that the biological age might be an important variable when examine children's physical activity. More mature children might have higher MET-values which would be reflected in the results as higher amounts of MVPA.

Physical activity on days with and without practices. Results comparing the average amount of daily physical activity between days with and without practices show that physical activity was higher on practice days at moderate and vigorous activity level. During the week the subjects had on average 30 minutes more moderate and 41 minutes more vigorous physical activity on practice days compared to weekdays without practice. For weekend days the difference was 27 more moderate and 32 more vigorous physical activity compared to weekend days without practice. The difference was significant for both these activity levels on weekdays and for vigorous activity level on weekend days. These results seem reasonable, since subjects had on average 36 minutes of moderate physical activity and 47 minutes of vigorous physical activity during practices which can be interpreted as additional daily physical activity. Also previous studies (Craft et al. 2012, Hebert et al. 2015, Wickel & Eisenmann 2007 and O'Neill et al. 2011) have given indications that participation into organized sport increases the amount of MVPA on these days. On the contrary, the average amount of light physical activity was lower on weekend days with practices compared to weekend days without practices. For weekdays the average amount of light physical activity was slightly higher for days with practice compared to days without practice. Therefore at least for weekend days it could be said that practice participation does not increase the amount of light physical activity on practice days, even though the average amount of light physical activity during practices was 6 minutes.

Previous studies among children by Wickel and Eisenmann (2007) and O'Neill et al. (2011) have also suggested that the increased amount of MVPA on days with organized sport is not maintained on days without organized sport. This same thing can be interpreted from the results of this study as well. Days with practices have more MVPA than days without practice. When focusing more detailed on the amount of increased activity on practice days, it can be seen that the additional amount of moderate and vigorous activity compared to days without practice was lower both for weekdays and weekend days than the amount of that activity in practices. Results show that the additional amount of MVPA on practice days is lower than that during practices. This indicates that physical activity in practices decreases the overall

MVPA on practice days outside practice time. The MVPA on days without practice is not on the same level as on practice days, but the amount of MVPA on non-practice days is higher than the amount of MVPA on practice days when physical activity during practice is not taken into account. However, straight conclusion should not be made, since it is not reliable to merely reduce practice time MVPA from total daily MVPA on practice days and compare that to non-practice days. When doing so, the analysis lacks the information what subjects would have done if not participated into practices. Therefore to study how participation into soccer practice influences children's total amount of physical activity another study with equal reference group would be needed. For that study it would be valuable to measure the amount and levels of physical activity for children who do not participate into organized sport and compare that to the ones having certain amount of practices during the measurement period.

It is seen in previous studies by Wickel and Eisenmann (2007) and O'Neill et al. (2011) that the MVPA on practice days is replaced by light physical activity on days without practice. In this study the amount of light physical activity on days without practice was higher during weekdays and almost on the same level than on practice days during week days. The total amount of physical activity was lower on days without practice both on weekdays and weekend days. Therefore for weekdays it could be argued that the MVPA on practice days is replaced by light physical activity on days without practice. However, since the total amount on physical activity is lower on days without practice, only some of the MVPA time is shifted to light physical activity and greater amount is spent sedentary. Same cannot be seen for weekend days, since the amount of light physical activity on days without practice does not exceed that of days with practice. So for weekend days it seems that the increased MVPA time on practice days is shifted to sedentary time on days without practice.

Physical activity in soccer practice. The question whether the physical activity in soccer practices is on such intensity level that it is beneficial on children's health lies on the intensity and amount of physical activity during practices. In general physical activity is seen beneficial for health and activity on moderate and vigorous level enhances fitness. The Finnish recommendations for physical activity (2008) also note that MVPA is needed to acquire health benefits. Previous studies by Golle et al. (2014) and Silva et al. (2013) have suggested that children engaged in sports clubs have better fitness and study of Hebert et al. (2015) suggests that children are more likely to meet the recommendations of physical activity when participating into organized sport, especially soccer. This is reasonable, since like previous studies indicate at least in soccer children are able to accumulate notable amount of MVPA during organized sport. In this study most of the physical activity in soccer practice was on moderate intensity level and also vigorous activity was attained. The average amount of over 35 minutes of moderate physical activity from practices alone does not cover the recommended daily amount of moderate physical activity. But adding to this the average amount of vigorous physical activity from practices rises the total amount of practice time MVPA to over 1 hour. So in this light the intensity level in soccer practices as well as duration of physical activity on that level are sufficient in regards of health benefits. However, it should be kept in mind that additional physical activity on light physical activity level is needed to cover the total amount of recommended daily physical activity and attain health benefits.

Limitations of this study. Measurement period included both week and weekend days, but only one practice was held on weekend day. Therefore it was not possible to make analysis between weekend time practice sessions. Also there was only one weekend during the measurement period and thus only two weekend days were included in the measurement period. Comparisons between week and weekend days were therefore made only around one weekend diminishing the reliability of results.

As the practice sessions included in this study were not strictly moderated, the activity between practice sessions may have differed due to different practice variations used. On the other hand because subjects' activity was not moderated from outside by controlled individual practices, the subject's PA might have been more self-controlled and reflecting better the individual level of PA. It would have also been interesting to examine, whether game situation would have differed from practice, but this was not included into this study's scope. Among the participants were two goalkeepers, who in general have less PA during practices, but whose measurement data was not separated in the results. Excluding the goalkeepers' practice time PA might have an effect on the analysis between most and least active subjects' practice time PA.

Generalization of the study results is limited, since this study had only 18 participants. However, it should be mentioned that the study group was rather homogenous since all the participants were boys born on the same year and lived in the same area. Also this study did not have a reference group and therefore it was not possible to compare the results to children with equal demographic values but not involved in soccer practices. A reference group would have helped to better examine the relationship between participation into soccer practice and children's total amount of physical activity. With reference group it would have been possible to more reliably measure whether participation into soccer practice increases total daily physical activity during that day.

As seen in previous studies (Epstein et al. 1996, Syväoja 2014 and Götte et al. 2017) it is more reliable to measure physical activity with activity meters than with questionnaires. This held true also for this study, since only two of the participants reported equal amount of physical activity as could be seen from the measurement data and almost half reported having less or more physical activity than the measurement data indicated. Therefore it can be seen reasonable and justified to measure children's physical activity with activity meters rather than with questionnaires. However, subjects were not supervised outside practice time and therefore it is not sure, whether the measured activity time is reliable. Even though measuring PA with activity meters is proved to be better way compared to questionnaires, the used measurement device had some limitations, since children could have been physically active in ways that are not properly measured with the activity meter used. These disciplines include for example cycling, swimming and different muscle strength exercises. During the soccer practice children's activity was measured also from heart rate together with activity meter's acceleration data and converted to MET-values as with other times the MET-values were calculated only from meter's acceleration data. Therefore the measurement procedure for PA differed between practice and other times. Despite this difference, the conversion of HR and acceleration based activity data to MET-values can be kept as reliable as is the MET-value calculation based only on acceleration data.

The limit values used for PA analysis in this study corresponded those introduced by WHO (2010) but it should be noted that the lower limit for VPA was set to 6 METs instead of 7 METs suggested by WHO for children and youth. Therefore the results may show higher amount of VPA than other studies made with children where the limit value for VPA has been set higher. However, the lower limit set for VPA does not affect the total amount of MVPA which is the main variable examined in this study for children’s overall PA. Also, the limit value does not affect the comparisons made inside this study group either, since the limit values were kept the same throughout the study group.

It is also possible that participation into this research made children more or less active than they would have normally been. Previous studies (Brusseau et al. 2012, Hardman et al. 2009 and Goodman et al. 2013) have shown that children are less active during winter time compared to other seasons, especially spring and summer. Therefore it is reasonable to question whether children would have been generally more active outside practice time, if the measurements were done during spring or summer time.

9. CONCLUSIONS

Main finding in this study was that physical activity on the same day before practice does have relationship with physical activity on soccer practice when practice days are examined individually. This information can be seen beneficial for soccer coaches, who hold practices for 12 to 13 year boys. Based on the results it is reasonable to encourage children to be physically active during the practice day rather than just rest and be sedentary. It it also valuable for children's parents to understand, what kind of relationship physical activity attained during the day has on activity in soccer practices. This helps parents to evaluate what reasons there might be behind their children's high or low activity in soccer practice.

Another interesting finding from this study was that most active half of the study group does have more moderate and vigorous physical activity during practices compared to less active active counterparts, but this difference is not significant. This finding is in line with previous studies, which have not found significant differences on practice time activity between high- and low-active children. Even though results from this study seem clear, they should be interpreted with caution. The study group was divided into two equal size groups based on average daily MVPA from the entire study period, practice time activity included and the division would've been different had it been based on different value. Both groups were also rather small having both only 9 subjects, so bigger study group could have also changed the results.

Also remarkable finding is that children engaged in sports club do get the recommended amount of physical activity on practice days, but especially moderate-to-vigorous physical activity on days without practice is significantly lower - keeping in mind though that measurements were done during winter time when children are shown to be more inactive compared to other seasons. Many children in the study group were not able to meet the recommended amounts of daily physical activity on days without practice, especially on weekend days. This makes it important to promote physical activity also on days without practices and to make children as well as their parents understand that physical activity is important every day, not only during practices.

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ATTACHMENT 1

Seuraavassa kysymyksessä fyysisellä aktiivisuudella tarkoitetaan kaikenlaista liikkumista, joka nostaa sydämesi sykettä ja saa sinut hengästymään. Liikkuminen voi tapahtua harjoituksissa, kavereiden kanssa leikkiessä tai pelaillessa, koulumatkalla tai liikuntatunneilla. Mahdollisia liikuntamuotoja ovat esimerkiksi juoksu, nopea kävely, rullalautailu, pyöräily, tanssi, rullaluistelu, uinti, lumilautailu, hiihto, jalkapallo, koripallo ja pesäpallo.

Kuinka monena päivän viimeisen 7 päivän aikana olet ollut fyyisesti aktiivinen vähintään 60 minuuttia päivässä?

Vastaus tutkimuksen ensimmäisenä päivänä (____ / ____ / 2017):

0 päivänä   1 päivänä   2 päivänä   3 päivänä   4 päivänä   5 päivänä   6 päivänä   7 päivänä

Vastaus tutkimuksen viimeisenä päivänä (____ / ____ / 2017):

0 päivänä   1 päivänä   2 päivänä   3 päivänä   4 päivänä   5 päivänä   6 päivänä   7 päivänä

ATTACHMENT 2

Taustatiedot

Pituus: ______ Paino: ______

Pvm	**La 4.2**	**Su 5.2**	**Ma 6.2**	**Ti 7.2**	**Ke 8.2**	**To 9.2**	**Pe 10.2**	**La 11.2**	**Su 12.2**	**Ma 13.2**	**Ti 14.2**	**Ke 15.2**
Herätys klo												
Koulu alkoi klo	x	x						x	x			
Koulu loppui klo	x	x						x	x			
Koulupäivän aikana liikuntatunti	x	x	K / E	K / E	K / E	K / E	K / E	x	x	K / E	K / E	K / E
Päivän aikana harjoitukset	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E
Nukkumaan klo												
Sairauspäivä	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E	K / E