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«School-based physical activity interventions for adolescents: To what extent do they prove effective, and which intervention methods and strategies seem most promising?»

A scoping review of studies conducted between 2010-2016

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# Acknowledgment

The master thesis are the end mark of two years in the program of «European Master in Physical Activity and Health. I remember starting the program in Rome almost two years ago, a bit nervous and to be quite honest, I did not really know what to expect of the study. But here I am, almost two years have passed since then, and now I am finalizing my master thesis. These two academic years have gone by so fast, but I have really enjoyed it. Of course there has been some bumps in the road along the way, but I have gotten to experience things through this past two years that i would not be without.

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## **Abstract**

### **Background:**

According to the recommendations from WHO, children and adolescents should participate in at least 60 minutes of PA a day in moderate to vigorous intensity, but

WHO report that more than 80% of the world's adolescent population is insufficiently physically active. School-based interventions are thought to be the most efficient setting in changing the total level of physical activity for children and adolescents.

### **Objective:**

The aim of this study is to conduct a systematically review of the single school-based intervention studies that have been conducted since 2010, focusing on change in objectively measured physical activity and BMI . An additional objective is to examine study effectiveness in light of intervention methods and approaches used.

### **Method:**

The literature in this review was obtained through the databases of *PubMed* and *SportDiscus*. Out of 646 studies, 44 were assessed for eligibility, and 8 were included in this review. Inclusion criteria was: RCT design, reporting on intervention methods and strategies, baseline and post measurements on BMI and objectively measured, school-based and concerning adolescents (age 10-19).

### **Results:**

The duration of the included studies varied from 15 weeks to 28 months. The number of participants ranged from 44 to 1440. Four out of eight studies obtained positive changes in the

primary outcomes. A common intervention component found in these four studies, was reserved time during the school day for PA. Three of the four studies which provided positive changes, was multicomponent interventions. Studies consisting of multicomponent approaches and with family or parental involvement provided the strongest evidence of success.

### Conclusion:

Summarized results in this review confirms that school-based interventions can provide a positive change in total PA level, if the method and approach are implemented correctly.

A multicomponent intervention consisting of time set aside for PA through activity breaks and enhanced physical education lessons, in addition to standard curricula and with parental involvement, provided the strongest evidence regarding positive changes in PA for children and adolescent.

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# 1.0 Introduction

Physical activity (PA) is a factor that can profoundly influence the overall public health and the well-being of humans. The World Health Organisation (WHO, 2017) states that PA can prevent and treat up to 30 different conditions and diagnoses. The mortality rate due to lifestyle diseases caused by inactivity and sedentary behaviour have increased drastically during the last decades. Inactivity have by WHO been reported as the fourth leading cause of global death, and they estimate that 3.2 million people die each year due to this. WHO also report that more than 80% of the world's adolescent population is insufficiently physically active (WHO, 2017).

Adolescents are defined as the period after childhood and before adulthood and concern people in the range of age of between 10-19 (WHO, 2017). A person develops the physical foundation up until the age of 20-25, then what is referred to as «ageing» intervenes. Ageing is defined as the decrease in functional reserve capacity (tissue/biochemical/cellular) of all organ systems as a function of time (Caserotti, 2016). The process of ageing and the foundation of a healthy life is developed during childhood and adolescence, hence the importance of this group to be physical active. Schools are considered to be the best environment to change and intervene the physical behavior of this group. The main reason for why so many intervention studies are conducted with the school as the venue, is based on the amount of time during a day they spent there, and because it gives the researches the possibility to embrace a large group of participants at a time (Magnusson et al, 2012).

## **2.0 Theory**

### **2.1 Physical activity defined**

World Health Organization (2017) defines physical activity *«as any bodily movement produced by skeletal muscles that requires energy expenditure»* . The definition of physical activity is a broad one. As defined, we can include activities such as playing, exercise, sports, physical education, since all of these are activities which include bodily movement. The most common misconception is the mixing of PA and exercise. Exercise is a subgroup of PA, and include planned, structure and repetitive activity aimed to improve or maintain physical fitness.

### **2.2 Recommendations regarding physical activity for adolescents.**

According to the recommendations from WHO (2017), children and adolescents should participate in at least 60 minutes of PA a day in moderate to vigorous intensity. The recommendations for adult consist of at least 150 minutes of PA with moderate intensity or 75 minutes a week of vigorous intensity. Bone and muscle strengthening activities should be dominant. These two are important for all ages, but the bone strengthening activities are more relevant for children and adolescents, since their skeletal is still growing and developing. These activities should occur in regular child's play, which often includes running and jumping. WHO also states that their recommendations can be divided into three sessions lasting ten minutes each, for people finding it hard to implement 30 consecutive minutes a day.

### **2.3 Physical activity - different intensities**

Regarding the different intensity levels in the recommendations, moderate intensity can be explained as activities where ones rate of heartbeats increases. WHO are exemplifying activities

where this occur as: walking at the speed of 4,7 km/h, housekeeping, gardening, walking outside with your domestic animals, construction work, dancing, moving/carrying moderate loads, bicycling at 16 km/h and sexual activity. Moderate intensity is also explained as activities with the use of 3-6 MET. MET stands for Metabolic equivalent, and is often used to explain the intensity of physical activities. *«MET is the ratio of a person's working metabolic rate relative to their resting metabolic rate. One MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1kcal/kg/hour.»* (WHO, 2017, p.1). Exemplifying by METS then, moderate intensity would be equal a level of 3-6 METS, that is a level of intensity 3 to 6 times higher than sedentary behaviour.

Vigorous intensity activities equals those with an energy expenditure from 6 MET and above, that is six times higher than sedentary behaviour. Examples of activities in this group would typically be jogging and running, participating in sports such as football, swimming, combat sports, strength and resistance training. According to the recommendations, activities conducted in a mode of vigorous intensity benefit health more than those moderate in intensity. (WHO, 2017)

## **2.4 Level of participation in physical activity**

In 2010 WHO reported that 23% of the world population at age 18 and up, were insufficiently physical active. Hence, they are not considered to fulfil the recommendations set by WHO. In high income countries the percentage amounts to 20% of male and 27% of the female population. In low income countries 12 % of the men and 24% of the women were insufficiently physical active. In the same report, they stated that 81% of the adolescents worldwide aged between 11-17, did not fulfil the recommendations, with a percentage of 84% of the girls and

78% of the boys. Based on this report, one can conclude that the number of woman and girls not fulfilling the recommendations are of a higher percentage than the men and the boys.

The prevalence of insufficient PA differs among the different regions. WHO reported in 2010 that the prevalence of insufficient PA amongst adolescents from the South-East Asia was 74%. The highest level of insufficient physical activity were found in the Eastern Mediterranean Region (88%), the African Region (85%) and the Western Pacific Region (85%) (WHO, 2017). Norwegian trends are slightly different among adolescents. In a national study published in 2012 in Norway, it was reported that 58% of boys at the age of 15 and 43% of the girls fulfilled recommendations regarding PA (Anderssen, 2012). A common trend, both globally and in Norway, is that children of parents with higher education are more physically active. If we look at the adults in Norway compared to the global numbers, it is not that different. In a study from 2015 32% of the adults aged between 20-64 fulfilled the recommendations, 34% being women and 29% men (Anderssen, 2015). Interestingly, the amount of adults that were insufficiently physically active, were higher in in high income countries. This is somewhat surprising given that they also report that people with a higher educational level is more active than the ones without any higher education.

Table 1):



(Table showing the percentage of Norwegian adults at different educational levels fulfilling the recommendations regarding PA set by WHO. The columns on the left is regarding women and right the men. Yellow= Primary school, Orange= High School, Green= College/University <4 years, Blue= College/University >4 years). (Helsedirektoratet, 2016).

Conclusively there are more adults without a higher education in low income countries that fulfil the recommendations than it is in high income countries. In the report from 2015 by Anderssen et al, (table 1) the difference for both men and women between the ones with a low educational level (completed high school) and those with a higher educational level (—> 4 years College/University) that fulfil the recommendations, differs about 20%. The amount of Norwegian adults with a lower educational level that fulfil the recommendations is approximately 20% versus 40% amongst the ones with a higher education (Anderssen, 2015).

## 2.5 The role of physical activity in health

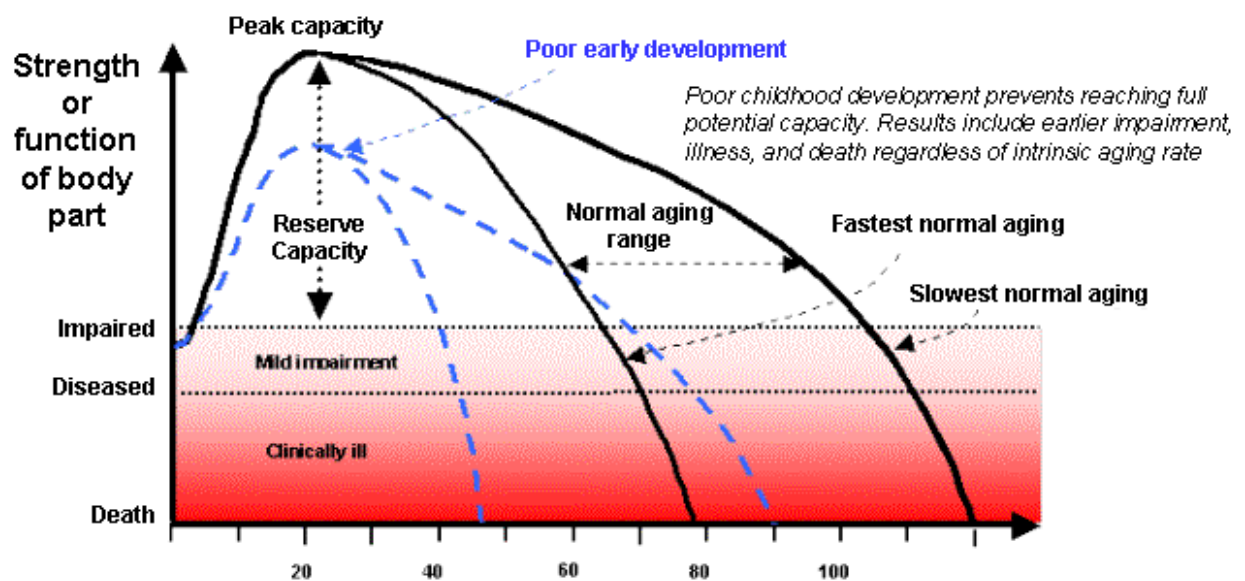
WHO have reported that by fulfilling recommendations regarding PA, up to 30 different conditions and diagnoses may be prevented. The most common diseases PA is reported to prevent or reduce is cardiovascular diseases (CVD), diabetes 2, colon and breast cancer, osteoporosis and depression and anxiety. Regular physical activity is also an important tool to regulate and controlling the weight of a person (Helsedirektoratet, 2016). In a review study by Thompson et al, published in 2003, they conclude that the reduction of CVD with PA as the treatment method is more beneficial than regular comprehensive treatment. PA as a prescription for prevention or reduction regarding diabetes 2, is also well documented. In a study conducted by Manson et al (1992) in the United States, done on 21000 male participants showed that 40 minutes a week of MVPA significantly reduced the prevalence of diabetes 2 amongst the participants. They also concluded that an increase of PA reduced the overall symptoms related to diabetes 2. PA is also reported to improve bone health, in addition to improve a persons physical functionality. In a review by Strong et al (2005), it is reported that child's play including running and jumping increase the bone mineral density the most. Strength and resistance training are also mentioned as beneficial activities for children and adolescents to develop strong skeletal muscles. (Strong et al, 2005). The positive effect of regular PA to prevent diseases and to improve a condition is reported by WHO as well documented (WHO, 2017). PA is important at all ages, but from a person is born until he or she dies, it benefits in different ways. Since this review is about adolescents, I will from now on focus on that specific age group.

## 2.6 Physical health in adolescence and the importance of physical activity

All of the benefits of PA mentioned above is also of great importance for the youth population.

As mentioned in the «*Recommendations regarding physical activity*» section, the bone and muscle strengthening activities are most essential ones. In addition to this, the development regarding their cardiorespiratory fitness, should also be a major focus. Up to age of around 20-25, a person develop the physical foundation for the rest of their life, until what's referred to as «ageing» intervenes (Caserotti, 2016). We can define ageing as the decrease in functional reserve capacity (tissue/biochemical/cellular) of all organ systems as a function of time (Figure 1). The body reaches peak capacity approximately at the age of 20-25. The body has reserve capacity to sustain normal functions under adverse conditions. Poor childhood development prevents reaching full reserve capacity, which can lead to earlier impairment or illness caused by ageing and death. (Caserotti, 2016).

Figure 1):



(Caserotti, 2016).

Conclusively you make the foundation for the rest of your life until you are approximately 20-25 years. It's never too late to start to be physically active, but building up a good foundation during childhood and the adolescent period will lead to a higher peak capacity. A higher peak and reserve capacity will slow down and hold back the prevalence of the pathway to disability.

## **2.7 Obesity**

«Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health.» (WHO, 2016). In 2014 1.9 billion adults globally was overweight, and 600 millions of these were obese. In the same year WHO also reported that 41 million children under the age of 5 were obese. The amount of overweight (BMI  $\rightarrow$ 25) and obese (BMI  $\rightarrow$ 30) (see fig) people globally has also doubled since 1980.

Physical activity is in many ways related to overweight and obesity, since insufficient physical activity and an increase of high fat nutrition are the main reasons for this lifestyle related condition or disease (WHO, 2016). Childhood obesity is also connected with the reserve capacity mentioned earlier. Obese children have a higher risk of being obese when becoming adults. Some of the risks associated with childhood obesity is that their development regarding their functional level can be interrupted in a negative way. This can occur by the physiological risk that is connected to obesity, such as hypertension, breathing difficulties, insulin resistance and the psychosocial aspects that can intervene (WHO, 2016).

The benefits of PA on obesity have been the case of a lot of different studies. For example in review study from Strong et al, they report that moderate PA sessions of 30-60 minutes 3-7 days a week can reduce the total body weight and visceral adiposity in children and adolescents. They



also conclude that it is more favourable regarding reduction in body fat, to have longer sessions (80.min-> a day) and keep up intensity while being active (Strong et al, 2005).

## 2.8 BMI

Overweight and obesity is based on the Body Mass Index (BMI). BMI is a tool, which is the result of a persons height and weight and can be calculated with : Kilograms (weight) divided in meters squared (height) (Figure 2).

Figure 2):

$$\text{Body Mass Index} = \frac{\text{Weight (in kg)}}{\text{Height}^2 \text{ (in m)}}$$

There are different classifications of BMI, but being overweight means that a person has a BMI over 25. Obese is classified as BMI over 30, but there is also subgroups under this term (Figure 3)

Figure 3):

BMI classification	
<b>Underweight</b>	<b>&lt; 18.5</b>
<b>Normal range</b>	<b>18.5 - 24.9</b>
<b>Overweight</b>	<b>≥ 25.0</b>
<i>Preobese</i>	<b>25.0 - 29.9</b>
<b>Obese</b>	<b>≥ 30.0</b>
<i>Obese class I</i>	<b>30.0 - 34.9</b>
<i>Obese class II</i>	<b>35.0 - 39.9</b>
<i>Obese class III</i>	<b>≥ 40.0</b>

(10 facts on Obesity, WHO).

A lot of the diseases mentioned earlier are lifestyle related and linked to overweight and obesity. Insufficient PA can lead to obesity, and along with obesity is the increase of a persons BMI. When a person's BMI is raised, there is a major risk for non-communicable diseases (NCD) to develop, such as: Cardiovascular diseases, which was the leading cause of mortality in 2012,

diabetes, musculoskeletal disorders and cancers. (WHO, 2016)

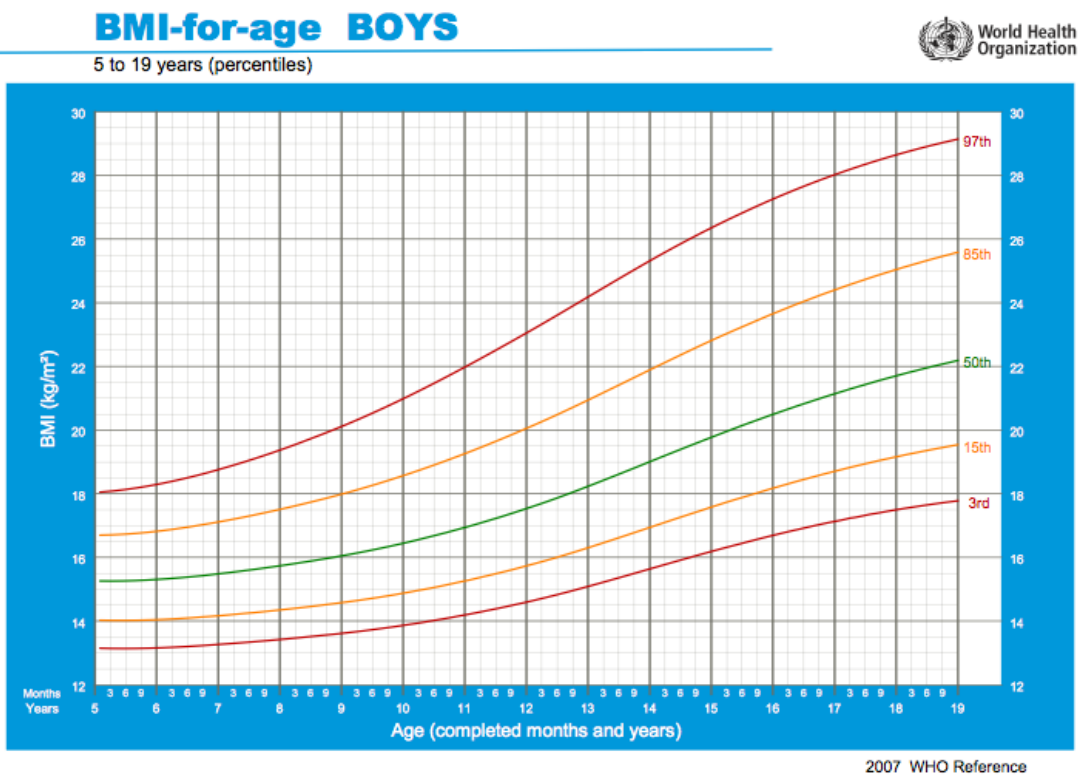
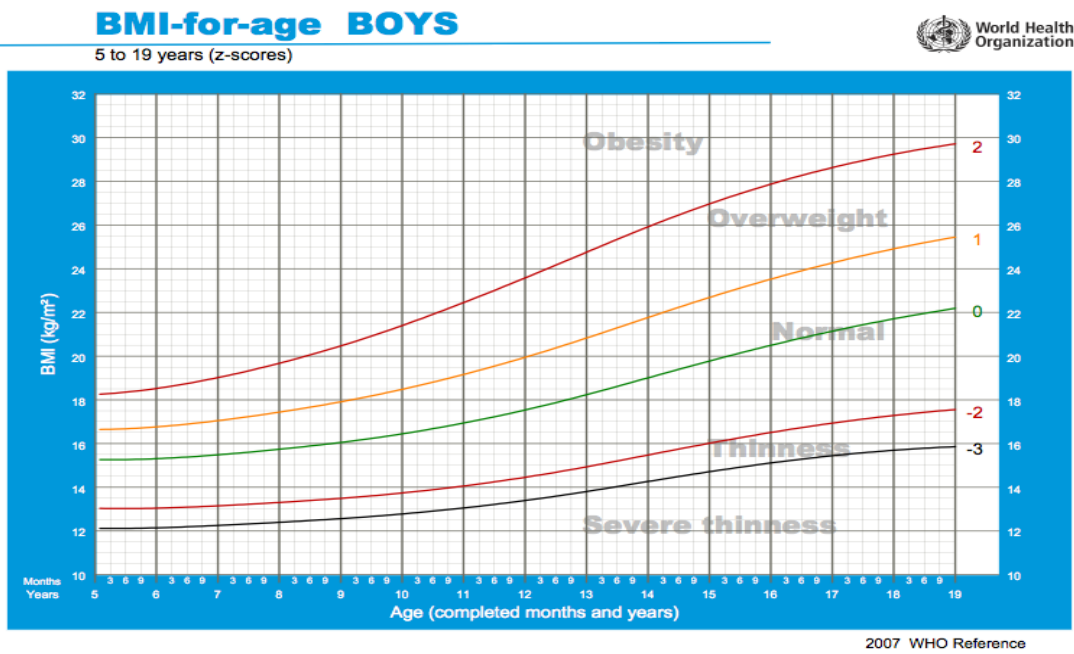
### **2.8.1 BMI for children and adolescents**

BMI for children and adolescents are calculated in the same way as for adults (KG divided in M squared), but are interpreted differently. BMI scores for children and adolescents are based on the «Center for Disease control» (CDC) growth chart (CDC, 2015). After the calculation of the BMI, it is expressed as a percentile or a z-score (Standard deviation score), both of them says something about the BMI relative to other young peoples BMI in the same age and gender (CDC, 2015). The difference between the percentile and the z-scores is that the *«z-score system expresses the anthropometric value as a number of standard deviations or z-scores below or above the reference mean or median value»* (WHO, 2017, p.1). (Figure 4 & 5)

The Percentile in the CDC growth chart says something about the measurement in relation to the overall youth population and what is above or below it (CDC, 2015). Below one can see the two different charts of z-scores and percentile on boys from the age of 5 to 19 years published by the WHO. The percentile in the CDC growth chart, are based on data from a national survey conducted in USA between the years of 1963-65 and 1988-94. Children's and adolescent's BMI changes as they grow, and that is why the measurements concerning their BMI is fluid and cannot be interpreted in the same way as adults (CDC, 2015). So the BMI for children and adolescents cannot really be classified in the same way as adults with normal weight in the range of 20-24,9 and overweight being form 25-29,9, because BMI for adults does not take gender or the fact that a young person's body is under development.

*«The BMI-for-age percentile growth charts are the most commonly used indicator to measure the size and growth patterns of children and teens in the United States.»* (CDC, 2015, p.1).

Figure 4 & 5):



(WHO, 2007)

## **2.9 Economic burden of inactivity**

It's common knowledge that being physical inactive is not a healthy way of living for an individual. But it affects the general population, and the society we live in, in a much bigger scale. An American study from 2016, concluded that the expenditure of 78,5 billion dollars was connected to physical inactivity in the US. This amount was based on several things such as medical treatment, insurance payments and earlier retirements (Oldridge, 2016). The obesity rate in the US is an extreme case, but also in a Swedish study from 2012, it was reported that their yearly expenditure connected to physical inactivity was approximately 25 billion Swedish kroner (Kvam, 2016).

## **2.10 Psychological/mental health in adolescence**

Mental health is about both positive and negative aspects of life. A study from 2005 said that approximately 27% of the EU-population have or have been experiencing a mental disorder the last 12 months (Kessler et al., 2005). Depression (clinical and non-clinical) is reported to be the most prevalent disorder concerning mental illness, and it's estimated that 5-10 per cent of the global population have or have had experienced clinical depression. Anxiety is another burden of diseases, and is the most common mental disorder in the United States. (Biddle & Mutrie, 2008)

Numbers from WHO reports that the prevalence worldwide of children and adolescents that experience mental disorders is 10-20% (WHO, 2017). Experiencing mental disorders in early years of life, can intervene with children and adolescents mental development. WHO says that if these conditions are not treated, it could lead to that this population would not be able to live productive and fulfilling life (WHO, 2017)

PA has become a popular alternative treatment method for people suffering from mental illness/disorders. This is because the benefits both physical and mentally has proven to be sufficient on people's health (Helgadottir et al, 2015). Regular PA amongst people suffering from mental illness, can have a positive effect on several aspects of a persons health. The most positive effects of PA on mental illness is, that a number of studies have showed a decrease in depression and anxiety symptoms, confidence is increasing, better quality of sleep and better social functions (WHO, 2017). Earlier studies have also concluded that PA as treatment for some mental disorders, can be equal as good as the use of for example anti depression medicine. (Helsedirektoratet, 2014). The benefits of PA related to mental disorders depends on the intensity. A study by Strong et al, showed that the benefits of PA was effective in reduction on anxiety and depression symptoms for adolescents.

## **2.11 School-based interventions**

The amount of school-based intervention studies have rapidly increased during the recent years. The background for this trend, is based on several facts. The most common is due to the amount of people that do not fulfil the recommendations regarding PA, which further has led to the global obesity epidemic of today (Magnusson et al, 2012). The main reason for why so many intervention studies are conducted with the school as the venue, is based on the amount of time during a day they spent there, and because it gives the researches the possibility to embrace a large group of participants at a time (Magnusson et al, 2012). Another reason why most of the intervention studies are being conducted in the youth population, is because the PA level of a huge amount of children and adolescents is too low, and earlier studies have shown that it is

possible to reverse the trends, or at least slow it down for this age group (Magnusson et al, 2012). Previous research concludes that the most effective method to increase PA level and prevent obesity in school-based interventions, have consisted of a multicomponent approach. The most effective components are reported to be individual focus, creating a good physical environment and physical educational lessons conducted by PE teachers or experts and activity breaks in addition to the standard curricula (Andrade et al, 2014). Family or parental involvement and support from the local community are also reported to play a major role in sustaining the level of overall PA achieved during school hours, and is also described as positive factor regarding the motivation of the participants included (Grydeland, 2013).

## **2.12 Objectively measured physical activity**

When conducting an intervention regarding PA in schools like the ones included in this review, the researchers must collect data that says something about how the intervention is progressing. They need this data to be able to analyze how effective or how their intervention is intervening which in this case is about the youths PA level. Whether they are effective or not, depends on which parameters they have set as their primary outcome measures. When measuring PA in general, there are mainly two different methods to obtain data. These are subjectively and objectively measurements. The most common subjective measurements regarding PA, are questionnaires and self-reported activity logs/ diaries (Trust & O'Neil, 2014). Since this review is about objectively measured PA, there will be no more elaboration on the subjective measurements. When objectively measuring PA, there are some different tools you can apply. As mentioned earlier I have chosen to look at studies where accelerometer has been the preferred tool of measurement in this review. I will come back to the accelerometer later, but first I will

briefly present some of the other common tools which is also often applied in PA interventions.

### **2.12.1 Heart-rate monitors**

Heart-rate monitoring (HRM) is measuring the rate of heart beats. The rate of heart beats in an indicator of energy expenditure and level of PA. The most common ways of HRM is done through a «pulse watch», where your heart-rate is monitored on the wrist or with a monitor placed with a rubber band around the chest, paired with the watch. Most of these pulse watches are also equipped with other functions which provide information concerning duration, frequency and intensity. It is of great importance that the watch is calibrated in the right way to the monitor around the chest, to avoid measurement bias. HRM is considered to be a valid and reliable method to measure PA (Sylvia et al, 2014). The limitations of HRM is that it does not take into consideration some of the confounding factors that can affect the heart-rate, such as stress and caffeine. Another limitation concerning measurement of total activity during a day is that when your working or eating etc, your heart-rate will of course be at lower stage than when doing PA, and this will affect the overall activity score. Neither does it take into consideration the gender, body composition or age (Trust & O'Neil, 2014).

### **2.12.2 Pedometers**

Pedometers are placed on the hip or around the waist of a person, and measures steps. One step is counted when there is a acceleration of the body's centre of mass during the gait cycle.

Pedometers are also used to measure energy expenditure and distance travelled, assumed that the pedometer is calibrated by the person using it. The importance of individual calibration is because the length of a persons step differs from person to person (Sylvia et al, 2014).

Limitations of the pedometer, is that it only measures vertical movement and not horizontal.

Neither does it say anything about intensity or frequency (Trust & O'Neil, 2014).

### **2.12.3 Accelerometer**

Accelerometers have in recent time, become one of the most common devices to measure PA. An Accelerometer is usually placed on rubber band around the waist, where the device is placed on the right hip. The accelerometers are programmed to monitor movement in three different planes, these are the anteroposterior, mediolateral and vertical and also acceleration. (Sylvia et al, 2014) Acceleration is measured through the value of counts. How the counts are converted depends on the interest of the ones that analyses the data. But the counts are mainly used to read of data concerning energy expenditure or work rate. When analysing the counts, the data you get is also relative to cut-points which is decided by for example the ones conducting an intervention (Trust & O'Neil, 2014). There are some different models of accelerometers, but the most modern and common types is Actipal and ActiGraph, they also say something about different PA intensities and the volume of PA. They are also a popular tool because they're able to store large amount of data at a time (Sylvia et al, 2014). Accelerometers are also very commonly used when measuring PA on children and adolescents, which is also one of the reasons why I've chosen this as one of the parameters in this review. Some of the limitations with accelerometers are that most of them are not able to tell the difference of the position of the body (sitting, lying down or standing), which include activities such as cycling. The accelerometers are not water-proof, which rule out the opportunity to monitor activity in water. But beside these limitations, accelerometers are known as a valid and reliable tool when investigating levels of PA (Sylvia et al, 2014).



## **2.13 Aim of study**

The aim of this study was to investigate the extent to which school-based interventions conducted between 2010-2016 have proven to be effective regarding change in level of PA and BMI.

## **3.0 Method**

### **3.1 Search Strategy and selection criteria**

I took advantage of conducting a scoping review of single studies identified as meeting the methodological criteria set for my collection of studies included in my review (Atkinson, 2012).

To be able to trace and compare relevant interventions reported in the format as single studies, it is important to conduct a systematic literature review based on search in relevant databases. On our school web page, we have full access to a great number of online scientific databases.

PubMed, SportDiscus, Sportline, Web of science and SweMed to mentioned some of them. After scoping the different databases, I ended up with putting my search terms in PubMed and SportDiscus. This was based on where I thought I could find the most relevant studies.

Another reason for this priority was to avoid overlapping of studies, and that I could focus on the results of the two others.

It is of utmost importance to make the search in the scientific databases with accurate search terms, also known as key words. The main key words I was looking for in my search, included: School-based, physical activity, intervention, adolescents. I also had some limitations to make my search as accurate as possible, these consisted of: that they were published between

2010-2016, that the study was a randomized control trial and that the participants of the study were between the age of 10-19. These key words and limitations developed into the inclusion and exclusion criteria that later defined what kind of studies that ended up in this review.

### **3.2 Inclusion Criteria**

The screening of the individual studies and inclusion of them for further examination in the review was based on a clear set of exclusion and inclusion criteria. The inclusion criteria was: studies revealing a RCT design, studies reporting on intervention methods and strategies. Studies that presented baseline and post results on measures such as BMI and level of activity, which was objectively measured. The last inclusion criteria is that the interventions is concerning adolescents. Adolescents are defined as young people between the age of 10-19. (WHO, 2017).

(see flow chart)

### **3.3 Exclusion criteria**

Studies excluded from this review was studies that was not written in English and that were not available in full text. I also excluded studies that did not present the BMI and accelerometer measurements at baseline and at the end of the interventions. Studies conducted out of school even though they included adolescents attending a school, were also excluded. (see flow chart)

### 3.4 Why RCT as one of the inclusion criteria?

A randomized control-trial has an experimental approach, and a RCT is said to be the «golden standard» when it comes to examine an effect of an intervention. It is also methodologically considered to be the strongest design of an intervention study regarding physical activity.

(Sullivan, 2011). This is based on the fact that the participants in an intervention randomly gets divided into two groups, often referred to as a intervention group and a control group. Dividing an intervention in two groups like this, makes it easier to compare the two groups and to see if one group had a larger effect than the other (Svartdal, 2012).

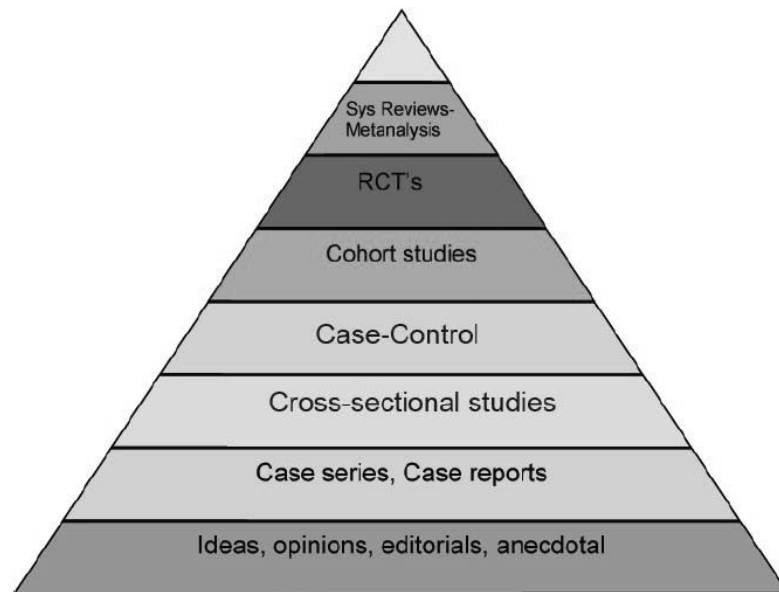
Randomization should result in two equal groups. By equal I mean that the number of participants and in this case that the participants physical level is as similar as possible. Often when using RCT as design, blinding or double blinding is used, but it is not always possible to blind (Karanicolas, 2010). For example when testing a new medicine on two groups, the blinding would be necessary to be able to compare the outcomes of the different treatments, but when conducting an intervention regarding physical activity, it is very hard to use blinding, because the staff that are conducting the intervention will obviously know who they coach or train.

*«It is very difficult to blind a participant to their study group if exercise is the intervention. This element of quality is more appropriate to pharmaceutical interventions where blinding for both researchers and participants reduces the risk of selection bias.»* (Foster, 2005, p.11)

But even without blinding, RCT is still a valid and reliable methodological design when conducting interventions concerning physical activity (Helsedirektoratet, 2016). RCT is also considered to be on the top on the hierarchy of evidence pyramid (see fig 6) . This pyramid tells us which study design that provides the best evidence, and rcts are considered to be one of the leading designs, because of the blinding included which also is an important factor in controlling

bias. (Petrisor & Bhandari, 2007). (see figure 6)

Figure 6):



(Phillips, 2014)

### 3.5 Literature search

The first databased i used was PubMed (US National Library of Medicine). PubMed is a free version of Medline, and it consists of nearly 20 million different references from different scientific journals (Kilvik & Lamøy, 2005). As a student at The Norwegian school of sports science and by entering the scientific databases through the schools library page, you gain full access to all of the studies on PubMed. In PubMed I used the «Advanced search» option. My first search included: School-based) AND physical activity) AND interventions. I also used these filters: Humans, Time period: 01.01.2010 - 31.12.2016, Article type: Randomized control-trial. Ages: 13-19. This resulted in 506 different studies, but since i wanted to find studies were the values of Body mass index (BMI) and accelerometers was presented both at baseline and post in the interventions, i did a more specific second search. (see flow chart)

In the second search I typed in: «Physical activity) OR Physical fitness) AND Physical education) OR Health education) AND Intervention) AND Accelerometer[Text Word]) AND BMI[Text Word]) OR Body Mass Index[Text Word]) AND School-based» Filters: Randomized Controlled Trial; Publication date from 2010/01/01 to 2016/12/31; Humans; Adolescent: 13-18 years. The second search resulted in 37 different studies. After the screening of these 37 studies, 32 of them was excluded because they did not meet the inclusion criteria. The 32 studies was excluded after a systematically screening which included reading the abstract of them and by searching for the key words in the full text version of them. Most of them were close to be included, but I chose to follow my inclusion criteria very strictly, to avoid a decreased relevancy. Of the studies that came close to be included, they either lacked BMI as a parameter or the use of accelerometer. Many of them also used subjective measurements, such as questionnaires. After the screening I also had to exclude some studies that was conducted by objectively measured physical activity, but the values that they used were for example the differences in % body fat or the values of blood pressure, which made them unsuitable for this review. That made the total of studies included from the search in PubMed down to five. These five single studies were all conducted at a school, with adolescents as the participants, they used RCT as design, ,they focused on physical activity change by using pre- and post-measures were both BMI and accelerometer, and the studies was published between 2010-2016. (see flow chart)

SportDiscus was the second database I made use of. SportDiscus is a database which consists of references from approximately 1500 different scientific journals. The main topics in this database is physical activity, physical exercise and sports (Kilvik & Lamøy, 2005).

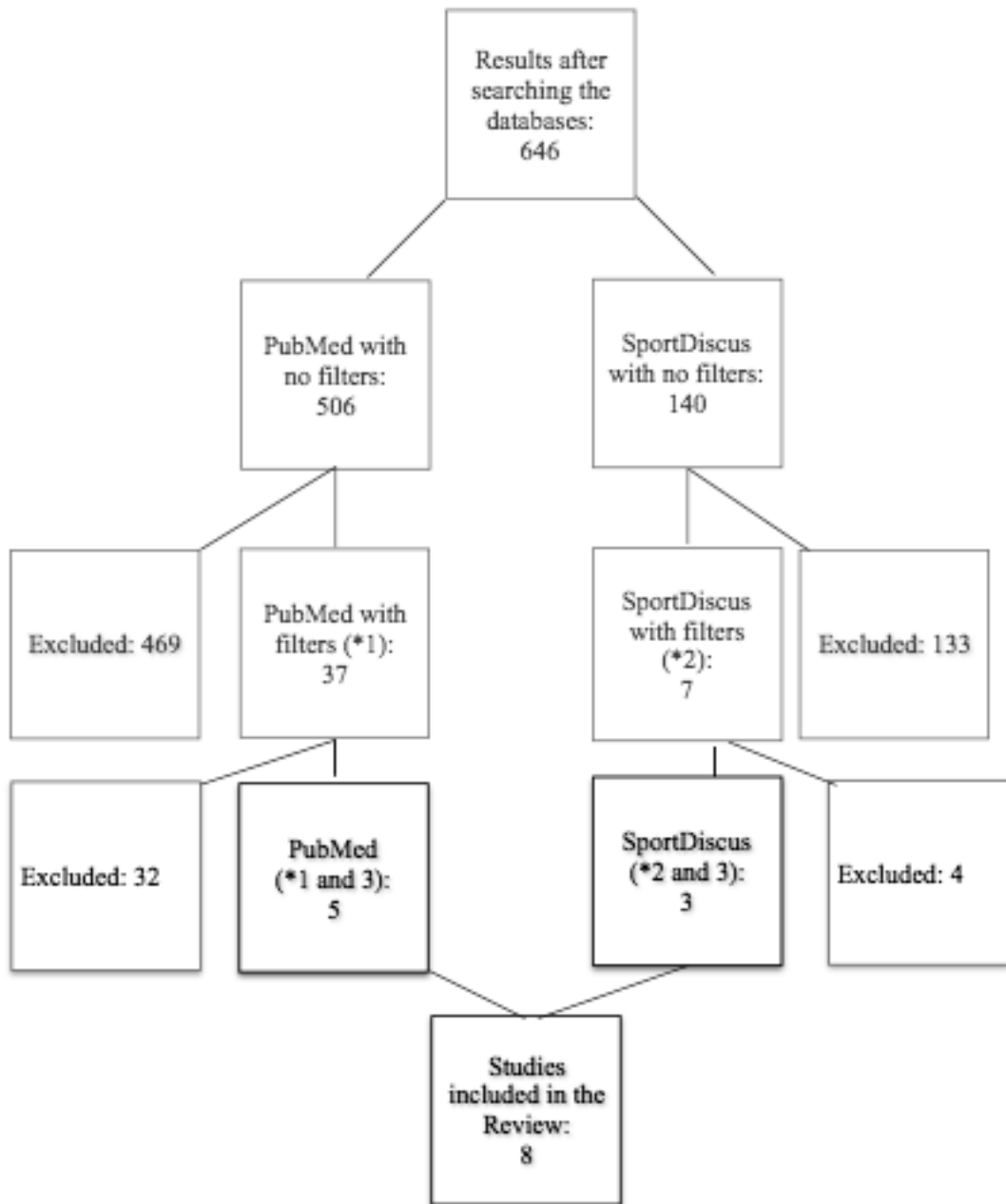
The SportDiscus database was as with PubMed, accessed through the webpage of The

Norwegian school of sport science within the library page. The layout of SportDiscus was a bit different from Pubmed, regarding the filters you could apply. In SportDiscus, I entered the database and pushed the «Advanced search» button.

In my first search I typed in: School based AND physical activity AND interventions AND Adolescents. This first search was done without the usage of any filters, I did this to get a overview of the different studies out there. Unlike PubMed, I was not able to locate the section where I could limit my hits by the age groups of the participants, so I decided to put the term *Adolescents* before pushing search. This first searched resulted in 140 hits. (see flow chart)

The second search included these terms in the search field: School-based AND physical activity AND Interventions AND adolescents. The filters/limiters I used was: Published Date: 20100101-20161231; Peer Reviewed, Narrow by Subject: - randomized controlled trials. After applying the filters with the first search, i ended up with 7 hits. Of the 7 hits, 4 was excluded due to missing out on one or more of the inclusion criteria. Examples of criteria leading to exclusion was the same here as on PubMed, such as subjectively measured physical activity in stead of objectively measured, lack of outcome measures that was needed or that they had focused on different parameters than the ones needed do meet the inclusion criteria of this review. (see flow chart)

Flow Chart:



1. \* Filters: Randomized Controlled Trial; Publication date from 2010/01/01 to 2016/12/31; Humans; Adolescent: 13-18 years.
2. \* Filters: Published Date: 20100101-20161231; Peer Reviewed, Narrow by Subject: - randomized controlled trials.
3. \* Studies able to meet all of the inclusion criteria.

## 4.0 Results

In the following chapter, I present the results of included studies.. As depicted in table 2, first I give an outline of each study including author/year, country of origin, number of participants, gender distribution, aim of study/objective and duration. Then, a summary of each study is presented in text format.

### Study Characteristics

(table 2):

Study number	Author/Year	Country of origin:	Number of participants	Gender Distribution %	Aim of the study/ Objective	Duration
1	Kriemler et al. (2010)	Switzerland	502	Boys: 55 Girls: 44	Effectiveness of a school based physical activity programme.	9 Months
2	Ridgers et al. (2010)	England	470	Boys: 49 Girls: 51	Effects of a playground intervention.	12 Months
3	Andrade et al. (2014)	Ecuador	1440	Boys: 37 Girls: 62	School-based health promotion intervention on physical fitness.	28 Months
4	Grydeland et al. (2013)	Norway	700	Boys: 44 Girls 56	Effects of a school-based intervention program.	20 Months
5	Lubans et al. (2012)	Australia	357	Girls: 100	Impact of a 12-month multi-component school-based obesity prevention program.	12 Months



Study number	Author/Year	Country of origin:	Number of participants	Gender Distribution %	Aim of the study/ Objective	Duration
6	Farpour-Lambert et al. (2009)	Switzerland	44	Boys: 37 Girls: 63	Effects of physical activity on systemic blood pressure (BP) and early markers of atherosclerosis in pre-pubertal obese children.	6 Months
7	Dewar et al. (2013)	Australia	357	Girls: 100	Impact of a school-based obesity prevention program.	24 Months
8	Ford et al. (2013)	England	152	Boys: 52 Girls: 48	Whether an accumulated brisk walking programme, performed during the school day, is effective in changing body composition.	15 Weeks

1. *Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial*
2. *Twelve-Month Effects of a Playground Intervention on Children's Morning and Lunchtime Recess Physical Activity Levels*
3. *A school-based intervention improves physical fitness in Ecuadorian adolescents: a cluster-randomized controlled trial.*
4. *Intervention effects on physical activity: the HEIA study - a cluster randomized controlled trial.*
5. *Preventing Obesity Among Adolescent Girls.*
6. *Physical Activity Reduces Systemic Blood Pressure and Improves Early Markers of Atherosclerosis in Pre-Pubertal Obese Children*
7. *The Nutrition and Enjoyable Activity for Teen Girls Study : A Cluster Randomized Controlled*

*Trial*

8. *Effects of a 15-week accumulated brisk walking programme on the body composition of primary school children.*

## **4.1 Included studies**

### **4.1.1 Kriemler et al, Switzerland 2010.**

This study was published by Kriemler et al in 2010 in *The British Medical Journal*. The aim of this study was to assess the effectiveness of a school based physical activity program during one school year on physical and psychological health in young schoolchildren. The design for this intervention was a cluster randomized control study. The intervention consisted of 502 participants in total and the duration was of 9 months. The intervention group consisted of 297 participants, while there was 205 in the control group. The participants in both groups followed the ordinary time schedule regarding PA, which included 3 x 45 min a week of PA lessons given by the classroom teacher. In addition, the intervention group received coaching and supervising by a physical activity teacher in two extra PA lessons a week, and daily activity breaks at school and PA homework. The primary outcome measures were body fat, aerobic fitness, physical activity and quality of life. The secondary outcome was BMI and cardiovascular risk score.

Of the 502 participants, 498 completed both baseline and follow up measurements.

The follow up measurements showed an increase in PA amongst the participants in the intervention group in school time compared to the control group. The most favourable intensity for the ones with an increase in PA level was at the moderate to vigorous level. The daily level of PA in the two groups did not show a significant difference. Regarding the BMI, both groups did actually have a slightly increase in their scores. The conclusion of the study is that the intervention group had an increase regarding school time PA level compared to the control

group, both not on the all day PA score.

#### **4.1.2 Ridgers et al, England, 2010.**

This study was published by Ridgers et al in 2010 in the *Journal of Physical activity and health*.

The aim of this study was to: Investigate the 12-month effects of a playground intervention on children's moderate-to-vigorous (MVPA) and vigorous physical activity (VPA) during morning and lunchtime recess. The design of the study was a randomized control study. This study included of 26 schools with a total of 434 participants at baseline. The schools were divided into two groups, which consisted 15 schools with 231 participants in the intervention group and 11 schools with 203 participants in the control group. The duration of the intervention was 12 months. The interventions schools were granted 20.000 £ each from the Department for Education and Skills, to change the playground environment by a sporting playground design. The sporting playground design aims was to increase the level PA for the youth population and avoid social exclusion and playground issues. The control schools were not granted any money, but had access to normal recess time equipment such different balls and jumping ropes etc. The primary outcome measurements was change in BMI, average time spent on PA in recess time (morning and lunch) and level of PA. The measurements were collected at baseline, post 6 months and at 12 months post from baseline.

The intervention resulted in an increase regarding PA level for the intervention group. The biggest increase was 6 months post, but from 6 to 12 months post from baseline the level was decreasing. The authors of the study discuss whether it has to do with the participants ageing, and the fact that older children are less active. The total of minutes spent on PA for both groups was actually slightly lower post 12 months than at baseline. There was also an increase in BMI

for both groups, where the intervention group went from 17.8 to 18.4 for the boys from baseline to 12 months post and from 17.4 to 18.1 for the girls. In the control group both sexes had less increase in the BMI compared to the intervention group. The boys had the smallest increase from 17.3 to 17.6 and the girls from 17.7 to 18.3. The conclusion was that there were an increase in the total level of PA for the intervention group.

#### **4.1.3 Andrade et al, Ecuador, 2014.**

This study was published in the *International Journal of Behavioural Nutrition and Physical activity* by Andrade et al, in 2014. The aim of the study was to see if a School-based intervention improves physical fitness. The design of the study was a cluster randomized control trial. This intervention consisted of a total of 20 schools. Of the 20 schools, 10 schools with 700 participants from 8th and 9th grade formed the intervention group and 10 schools with 740 participants from the same grades became the control group. The duration of the intervention was 28 months from allocation to follow-up. The intervention group was put on the *Physical activity environmental strategy*, which consisted of the *educational package*. This also included involvement by the parents of the participants in the intervention group. Both the adolescents and their parents were included in different workshops and social events where they got a introduction and a comprehensive exposition regarding healthy eating and PA. In addition the intervention group also had *interactive sessions with famous young athletes*, where the young athletes gave lessons about the importance of physical activity. Representing an environmental attribute implemented in the intervention group, a walking trail was established to facilitate the access to be physical active. The control group did not receive any extra attention, and they followed the standard curriculum provided by the Ecuadorian government. The standard curriculum consisted of 80 minutes of mandatory physical education a week, which both groups followed

throughout the whole period of the intervention. The primary outcome measures was physical fitness (Eurofit battery), screen time and PA through accelerometers. Changes BMI was a secondary outcome measure. These measurements were collected at baseline and 28 months post of the baseline.

The total level of daily PA decreased in both groups, but there was a slightly increase in both groups regarding their physical fitness scores. An increase regarding time spent sedentary was also observed. There was not a significantly difference in the BMI scores in any of the two groups. The authors conclude that the intervention had a positive effect on muscular strength, based on the increase in physical fitness, but that a positive change regarding the adolescents' time spent on daily physical activity could not be observed.

#### **4.1.4 Grydeland et al, Norway, 2013.**

This study was published in the *International Journal of Behavioural Nutrition and Physical activity* by Grydeland et al, in 2013. The aim of this study was to investigate effects of a school-based intervention program: the HHealth in Adolescents (HEIA) study, on change in physical activity. The design of the study was a cluster randomized control trial. The total number of 11-year old participants was 2165 at the allocation, but only 700 of these were included in the study based on that those were the only ones who had valid accelerometer measures at both baseline and follow up. This resulted in 215 participants at 12 schools in the intervention group, and 485 at 25 schools in the control group. To skewness of participants that in the two groups that was included was because that a larger amount of the participants intended to be in the intervention group did not provide valid measurements to be included. The duration of the intervention from baseline to post follow up, was 20 months described as two academic years. The intervention

started with a kickoff for the teachers at the intervention schools to inform and encourage them, as teachers were key persons to implement the intervention according to plans. The teachers were also given courses by trained staff, focusing on how to plan and implement PA that embraced everyone. The intervention schools had an extra 10 min break a week for PA, fruit and vegetables break and in addition they were given an activity box which included sports equipment and toys they could use in recess time. The intervention group were also given PA homework, and there were also ongoing campaigns regarding active transport to and from school. The classroom teachers also gave lessons throughout the whole period about nutrition and healthy living. In the second year of the intervention, the intervention group also got pedometers handed out, which they used in some specific periods, to stimulate activity amongst them. The primary outcome measure was PA monitored by accelerometers (ActiGraph) through cpm, while the secondary outcome was BMI.

The overall level of PA increased in both groups. As assumed, the intervention group had the strongest change in total PA with 473 counts per minute (cpm) at baseline to 570 at post intervention, with a net change of 44 cpm to the benefit of the intervention group. The control group changed from 511 cpm to 564 cpm from baseline to post intervention. Surprisingly there was a higher increase in total PA in the intervention group during weekend days (424cpm - 560cpm) than week days (509cpm - 574cpm). The cpm score was higher during the week days, but the strongest increase was in the weekend days. While the differences between genders concerning the overall level of PA was not that strong the girls (496cpm - 510cpm) revealed a stronger increase than the boys (495cpm - 499cpm) in minutes spent on sedentary activities, but in minutes spent in moderate to vigorous physical activity (MVPA), the boys (68 - 75) had a higher increase compared to the girls (60-62). Another interesting finding was that the normal

weight participants had a much stronger increase in total cpm from baseline to post intervention than the ones defined as overweight. No significant changes in BMI were reported for those 700 participants with valid accelerometer measurements. In conclusion, the intervention was shown to have a positive effect regarding the total level of PA amongst both groups, but the effect was significantly higher in the intervention group.

#### **4.1.5 Lubans et al, Australia, 2010.**

This study was published in *Arch Pediatrics Adolescent Medicine* in 2012 by Lubans et al. The aim of study was to Evaluate the effects of the Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) program. The design of the study was a randomized control trial. The total number of participants was 357 and they were between the ages of twelve to fourteen. The 357 participants were randomly divided into a intervention group (n=178) a control group (n=179). The duration of the intervention from baseline to follow up was 12 months. The teachers responsible for the implementation of the intervention at the intervention schools were attended a 1-day workshop given by the local university every quarter of the school year. This workshop included lessons and information about PA, nutrition and healthy living. In addition, all of the intervention schools received an equipment pack each, contained sports equipment with a total value of 1300 \$. The intervention consisted of different components, such as enhanced school sport sessions. These were conducted and supervised by the PA teachers at each school and included PA sessions from 60-80 minutes with a broad range of different activities for the participants. They did also have daily lunch-time PA sessions throughout the intervention. Some of the other components included for the intervention group was: Interactive seminars, nutrition workshops, handbooks and pedometers for self-monitoring, parent news- letters, and text messaging for social support. The control group was also given the equipment pack and a

minimized version of the intervention, this was to avoid demoralisation and rivalry between the two groups. The primary outcome measures was BMI, PA through accelerometers (Actigraph) with cpm, percentage of body fat, dietary intake and self-esteem.

The intervention for both groups resulted in a decrease in total time spent on PA. Despite the intervention components, the cpm/day score for the intervention group, went from the mean value at baseline of 388,6 cpm to 322,1 at 12 months post. The control group managed to keep their activity level quite stable, with a mean of 363 cpm at baseline to 360 at 12 months post. The intervention group had also a mean decrease of 12 minutes from baseline to post intervention a day spent on MVPA, from 33,5 minutes to 21,5. Both groups did also had a slightly increase regarding the BMI score, but it is referred to as a result of natural growth for adolescents aged 12-14. The only positive decrease in the intervention group, was the weekend screen time and the daily energy intake (kcal/day), but both of these were only slightly differences. Conclusively this intervention did not show a positive change in the participants BMI score, neither in the total amount of time spent on PA, surprisingly, the opposite occurred with negative trends in both of the outcome measures.

#### **4.1.6 Farpour-Lambert et al , Switzerland, 2009.**

This study was published in *Journal of the American College of Cardiology* by Farpour-Lambert et al in 2009. The aim of this study was to determine the effects of physical activity on pre-pubertal obese children. The design of the study was a randomised control trial. The total number of participants was 44, divided into two groups which consisted of the intervention group (n=22) and the control group (n=22). The duration of the intervention was 6 months. The intervention program included three 60 minutes sessions a week (total 180 min) of PA after school,



supervised by experienced physical education teachers. This was in addition to the 135 minutes a week of PA lessons they attended during school hours. A typical after-school session consisted of 30 minutes of aerobic exercise at a rate between 55-65% of their maximal cardiorespiratory fitness (CF), which was previously measured through a VO<sub>2</sub> max test on a treadmill. The percentage of their maximal CF was during the exercises monitored by heart rate monitor connected to a watch. If the participants during the exercise fell below the expected percentage of CF, they got a warning by the watch. Then followed 20 minutes of strengthening exercises for the whole body and 10 minutes of stretching and cooling down. The control group did not receive any extra supervised PA sessions during the first 3 months, but was asked to keep their level of activity as equal as at the baseline measurements. After the first 3 months, the control group were given the possibility to join the same program as the intervention group until the end of the six total months. The primary outcome measures was blood pressure, arterial intimal-media thickness which is explaining the thickness of the internal and middle arterial walls in the throat (Arnesen, 2016), BMI, body fat, CF (VO<sub>2</sub> max) and physical activity (accelerometer).

After the first 3 months, the intervention group had a slightly decrease in BMI z-score, and equal increase in PA measured through cpm (306.7 to 393.0). But they obtained a great decrease in total percentage of body fat. The BMI score for the control did not change significantly, but they had a great decrease in PA. After six months the blood pressure values decreased significantly in the intervention group which correlated with a decrease in the BMI score. A reduction regarding symptoms of cardiovascular diseases in both groups was also found, with the reduction occurring in the intervention group being stronger. The authors concluded that the PA program resulted in positive changes for both groups in their primary outcome measures, and that a 5 days a week program proved to be effective in reduction of BP, total body fat, BMI and symptoms regarding

cardiovascular diseases.

#### **4.1.7 Dewar et al, Australia, 2013.**

This study was published in *American Journal of Preventive Medicine* by Dewar et al in 2013.

This study is a follow up study based on the intervention from Lubans et al (2012), which is previously in this chapter. The aim of this study was to evaluate the 24-month impact of a school-based obesity prevention program among adolescent girls living in low-income communities. While the study of Lubans et al evaluated the effects of the NEAT-girls program from baseline to 12 months post, the purpose of this study was to evaluate the changes 24 months post baseline. The intervention program is mentioned broadly in the description of the previously study of Lubans and co-workers. Hence, I will not elaborate more on that. The 24 months follow up did not include any interference from the researches regarding PA sessions. The aim was to evaluate whether changes observed in the primary outcomes from pre-intervention to 12 months post-intervention prevailed or changed at 24 months.

In the study by Lubans et al, the intervention group had a decrease in cpm a day during the first twelve months. From post 12 months to 24 months, the intervention group had an increase in cpm a day from 298.3 as the mean value up to 323.4 while the control group had a decrease from 368.9 down to 350. Although there was an increase for the intervention group in cpm, the percentage of time spent at moderate to vigorous intensity decreased from 3.50% down to 3.31%. The reported positive decrease in daily screen time (minutes/day) from baseline to 12 months post, continued from 12 - 24 months post with a decrease from 231.4 down to 200. The mean BMI for both groups did not change significantly from 12 - 24 months post, but the mean energy intake (kcal/day) for the intervention group had large decrease from 2524 kcal/day down

to 2045.2 kcal/day. Decrease in energy intake did also occur for the control group from 2233.8 down to 2072.1, and the control group also had a decrease in daily screen time use from 248.6 minutes down to 207.1. The most drastically changes in both groups occurred regarding the percentage of body fat. The intervention group mean decreased from 32.73 down to 29.25, while the control group decreased from 32.55 down to 30.08. The other primary outcomes did not change significantly in the control group. Conclusively, it seems like there were more positive changes from 12 - 24 months post than from baseline to 12 months post in primary outcome measurements. The differences in the primary outcomes of the two groups, was favorable for the intervention group, but not as strong as hypothesized

#### **4.1.8 Ford et al, England, 2013.**

This study was published in *Journal of Sport Sciences* by Ford et al, in 2013. The aim of the study was to determine whether a 15-week accumulated brisk walking program, performed within a primary school setting, is effective in eliciting changes in body composition in 5 - to 11-year-olds. The design of the study was a randomized control trial. The total number of participants was 152 comprised of 79 boys and 73 girls. The participants was recruited from two primary schools in England, and they were divided into the intervention (n=77) and control group (n=75) regardless of the affiliation to their native school. The duration of the intervention was 15 weeks. The intervention group followed a brisk walk program which included of two sessions a day at least three days a week of walking at brisk intensity. The walking sessions took place at the start of the school day, and immediately after the lunch break. Each walking session lasted for approximately 15 minutes, and the brisk intensity was explained as a mean heart rate of 135.2 ( $\pm$  9.6) per minutes, and they were to walk the distance of 1437 meters ( $\pm$  7.6). To be able to obtain the heart rate and to reach the intended meters of walking, 8 participants were

randomly selected for each sessions and given a Polar watch to be able to keep track of these measurements. While the intervention group did the walking programme, the control group follow normal school curriculum. The primary outcome measurements was body composition/ BMI, skin fold thickness, physical activity (accelerometers) and dietary intake.

The intervention group had a significantly reduction in the mean percentage of body fat of 1.25%, from 14% down to 12.75%. This was related to the reduction in triceps and abdominal thickness. The control group did not show any significantly changes in these measures. As expected, the intervention group had a significantly increase in the cpm during school hours (09.00-15.00), but not outside of these hours. The dietary intake did not change significantly for any of the groups. Conclusively the brisk walking program had a positive effect on the body composition and percentage of body fat, which the authors report as beneficial in the prevention of obesity and the lifestyle diseases related to it. Another positive aspect is that through the brisk walk program, the children can almost fulfil the recommendations regarding PA during the school hours. But there was increase in the overall time spent on PA/day.

## 4.1.9 Summarized results.

Physical activity and BMI measurements at baseline and post for intervention groups in the study: (table 3):

<b>Study</b>	<b>Physical Activity CPM/ day Baseline Intervention Group</b>	<b>Physical Activity CPM/ Day Final Intervention Group</b>	<b>BMI Baseline Intervention Group (Kg/m<sup>2</sup>)</b>	<b>BMI Final Intervention Group (Kg/m<sup>2</sup>)</b>
Kriemler et al, 2010	770.0	726.0	17.13	17.36
Ridgers et al, 2010	*	*	17.60	17.95
Andrade et al, 2014	381.4	374.7	19.80	19.70
Grydeland et al, 2013	473.0	570.0	18.0	18.2
Lubans et al, 2012	388.6	322.1	22.70	23.30
Farpour-Lambert et al, 2009.	306.7	393.0	25.4	24.5
Dewar et al, 2013	298.3	323.4	22.70	23.86
Ford et al, 2013	211.7	348.3	17.1	17.7

(\* Measurements of PA was obtained through minutes/day in MPA or VPA instead of CPM/day.)

The studies included in this review was conducted from three different regions around the world, Europe (n=5), Oceania (n=2) and South America (n=1). The number of participants in these studies varied in samples from 44 to 1400. All of the studies comprised randomized control trials. The primary outcome measurements in the different studies varied a bit from physical fitness to energy intake et cetera, but as mentioned in the inclusion criteria, they also had to include BMI and objectively measured physical activity. A common denominator mentioned in

the background in all of the studies was the importance of an increase in total amount of time spent on PA. The aim was to slow down the global obesity epidemic and to prevent further development of diseases. The different components in the interventions varied considerably. 1. Extra PA lessons supervised by physical education teachers (Kriemler et al, 2010). 2 Granting of time to follow a brisk walk program in regular school lessons (Ford et al, 2013). 3. Upgrading of outdoor facilities with activity boxes filled with sports equipment (Grydeland et al, 2013). 4. Parental involvement. (Andrade et al, 2014; Lubans et al, 2010).

Four of the eight studies included, implemented physical activity interventions revealing a positive effect in my included primary outcomes. These four was the studies from Grydeland et al (2013), Farpour-Lambert et al (2009), Dewar et al (2013) and Ford et al (2013). A common intervention component found in these four studies was reserved time during the school day for PA. The study of Grydeland et al (2013) had activity breaks of 10 minutes once a week in addition to standard curricula. Farpour-Lambert et al (2009) provided 180 minutes extra of PA sessions a week, in addition two 135 minutes at school, while Dewar et al (2013) had lunch-time PA sessions in addition to the standard curricula which during the intervention also included enhanced PE sessions, and the study of Ford et al (2013) had at least 90 minutes a week of brisk walking at moderate intensity lasting for 15 weeks. Common for all of the studies is that they reported positive changes at post intervention. On the other hand, not all of them were related to an increase of PA or a decrease in the BMI score, which defined whether I define them to provide positive effects on primary outcomes or not.

## **5.0 Discussion**

School-based interventions have for a long time been rated as the most promising setting to increase the level of time spent on physical activity for children and adolescents. (Kriemler et al, 2011). This is based on the fact that this group of people spend most of their waking hours in a school setting and because it gives the researches the possibility to embrace a large group of participants at a time. The average time spent in a school setting for children and adolescents aged between 6-18 years, is 5-9 hours a day. (Magnusson et al, 2012). The aim of this review was to conduct a screening of single RCT studies conducted in a school setting, evaluate them and describe whether there were intervention effect on the primary outcomes and if, how they prove to be effective.

### **5.1 What makes a school-based intervention effective?**

Interventions regarding the promotion of PA amongst the youth population in a school setting include a lot of different components. However, every single intervention being conducted has their own primary outcome measures, which in recent years have varied from change in total PA level, energy intake, systolic blood pressure to physical fitness to mention some of them. This makes it very hard to evaluate every intervention under the same terms because of the different focus in each of the interventions primary outcomes. The changes occurring after an intervention in the chosen outcomes measures, is what makes it effective or not. The changes in the primary outcomes is based on several factors, and to be able to answer how the changes occur, we have to look into the different components and factors that intervenes in that process. A common denominator and the main interest for conducting the interventions in all of the included studies in this review was the promotion of PA and prevention of different diseases and obesity. As previously mentioned in this thesis, all of the included studies in this review revealed some

positive changes in their primary outcomes, but they were not considered to be effective, if the positive effects did not occur in my primary outcomes. For the included studies to be defined by me as effective, the interventions needed to obtain a positive change regarding the level of PA and BMI. The study of Kriemler et al (2010) which was a multicomponent intervention consisting of additional PE lessons, activity breaks and PA homework, had an increase in aerobic fitness, but not in PA through cpm a day, so therefore it was not defined as effective by my primary outcomes. The study of Ridgers et al (2010) included an upgrade of the outdoor facilities in the intervention schools, and reported positive changes in PA, but their measurements was reported through minutes spent of MVPA, which made it unsuitable for me to define it as effective, even though the results said otherwise. Taken the results of Ridgers and colleagues study into consideration, I should perhaps have chosen to include changes in MVPA as a primary outcome in addition to cpm a day regarding PA. In the intervention of Andrade et al (2014), multiple components intervened such as workshops on PA and healthy eating for the participants and their parents, social events including famous athletes which tasks were to motivate and encourage the participants and the creation of a walking trail. This intervention was conducted in Ecuador, and actually had a decrease in cpm a day from baseline to post intervention. The study of Lubans et al (2010) conducted in Australian adolescent girls, was also a multicomponent intervention consisting of enhanced school sport sessions, interactive seminars, nutrition work- shops, lunch-time physical activity sessions, hand- books and pedometers for self-monitoring, parent news- letters, and text messaging for social support. This resulted in a positive change in body composition, but a decrease in cpm a day, which made it ineffective concerning my outcome measures. The components and factors that intervened in the studies I considered to be effective varied from activity breaks at school, to enchanted PE lessons, extra PA lessons and following a walking program. In contrast to the study by Ford et al



(2013), the studies by Grydeland et al (2013), Farpour-Lambert et al (2009) and Dewar et al (2013) were multicomponent interventions. While the study of Ford and colleagues included the brisk walking program during school time and PA was the only component, the three others consisted of additional components such as nutrition guidance given to the participants, teachers and parents, free vegetables handed out in school, PA homework, parental involvement and different courses regarding healthy living. Another factor unique to the study of Ford et al (2013), was that their only aim was to increase the participants' level of PA, while the three others included the components listed above with an additional aim to also change physiological parameters.

In a review conducted by Kriemler and colleagues (2011) in which they examined the effect of school-based interventions on physical activity and fitness in children and adolescents, they analyzed twenty interventions with a duration of twelve weeks and more. Of the 20 studies in their review, the study of Kriemler et al (2010) and Ridgers et al (2010) from my review were included. 47-65% were found to be effective with respect to their primary outcomes, that was increasing total PA level. They also conclude that the most effective interventions were those consisting of a multicomponent strategies. These included interaction from PE specialists, parents, using more than one arena to facilitate increase of PA. Activity breaks during school hours, being granted sports equipment, having access to different outdoor facilities and adding extra PE lessons to standard curricula were mentioned as examples of components that had the most positive effects. The same review points out that interventions that focused on changing multiple health behaviors rather than just PA, were less effective. This makes sense taking into consideration that dividing the focus on different behaviors may reduce the focus on each outcome. This is in line with findings from studies included in the current review revealing

significant positive changes in PA in particular findings, as in the study of Grydeland et al (2013), revealing the quite strong increase in objectively measured PA, using a multicomponent intervention.

A review conducted by De Meester et al (2009) which included twenty studies but not any of the ones included in my review, did also support the evidence of a multicomponent intervention to be the most effective regarding increasing total level of PA. The same review, as well as that of Kriemler et al (2011) did also report that parental involvement was an effective intervention component. More specifically, parental support and their encouragement towards the children and adolescent had a positive effect. The duration of a school-based intervention is also an important factor that seems to influence the primary outcomes. Studies shown to be effective in my review lasted from 15 week up to 24 months. In my inclusion criteria, a certain duration of the single studies was not something I focused on. Nevertheless, reading other reviews such as the ones from Kriemler et al (2011) and De Meester et al (2009), both of them excluded interventions with a duration below 3 months. The main reason was that earlier research have provided evidence to conclude that a certain duration is needed to be able to detect significant changes and for a intervention to be extensively implemented. This suit well with the positive findings in the current review. Conclusively, the evidence of a multicomponent intervention seems the most promising. The review of De Meester et al (2009), and Kriemler et al (2011), include in total 40 studies. The majority of these, reported to have the greatest increase in total PA level, using multicomponent interventions with a duration of 3 months and more and with family support. Of the eight studies in my review, all of them exceeded the duration of 3 months. Six out of the eight included studies included parental involvement, these were the study of Lubans et al (2012), Andrade et al (2014), Dewear et al (2013), Grydeland et al (2013),,

Farpour-Lambert et al(2009) and Ford et al (2013). Nevertheless, only the four last ones (Dewar - Ford) provided positive changes concerning total level of PA and BMI.

## **5.2 School-based interventions and overall PA.**

The majority of the school-based interventions mentioned until now in this review, have led to a increase in the level of PA during school hours. But a common denominator often reported, is the lack of increase in PA besides school hours. One reason for this, as pointed out by Kriemler and colleagues (2011), is due to the lack of follow up studies being conducted, so a great number of the studies are not able to define whether the positive effect of their intervention continued after the post measurements. Regardless of that, one of the main findings in the review of De Meester and colleagues, was that *«improvements in physical activity levels by school-based interventions were limited to school related physical activity with no conclusive transfer to leisure time physical activity»* (De Meester et al, p.1, 2009). This explanation was mainly obtained in interventions without parental involvement, which further highlights the importance of this component. Thirteen of the twenty studies included in the review of Kriemler et al (2011) , integrated the families of the participants during the intervention, and these were also reported as the ones with the highest level of evidence for increasing total PA. As mentioned previously the four studies in this current review that had a positive change in overall PA a day, did also include family involvement as a component. So the level of evidence that family involvement as a component should be included in school-based interventions seems very strong. In a systematic review by Lai and colleagues (2014), they looked at follow-up studies of school-based interventions with a duration ranging from six weeks to six years and with a follow-up length ranged six months to twenty years. The aim was to investigate whether school-based interventions produced sustainability in PA, fitness and fundamental motor skills. The

systematic review consisted of fourteen studies, and ten of them reported a sustained impact on PA in the follow-up studies. Eight of the ten was described as multicomponent interventions, and family or parental involvement was listed as one of those components. These findings can be summarized by saying that the evidence is strong in obtaining positive changes in overall PA in school-based interventions and follow-up studies, when family or parental involvement have been one of the components.

### **5.3 Prevention of obesity and changes in BMI in school-based interventions.**

The main aim in almost every of the interventions in my review, was to increase either the level of PA in school or overall PA. To prevent diseases and especially obesity is also often mentioned in the background of each studies, on why an increase in PA is of great importance to achieve that. In all of the eight studies included in this review, BMI was calculated using (weight (kg)/height<sup>2</sup> (m)) and presented as the mean value of the participants in both the intervention and the control group. Four of the eight studies did also present BMI z-score. The z-score system expressed the anthropometric value as a number of standard deviations or z-scores below or above the reference mean or median value. (see figure 4). Of the eight studies included in my review, only the one from Farpour-Lambert et al (2009) had participants defined as obese. In addition to positive changes in PA through CPM/day, the participants also obtained a decrease in BMI from baseline the final measurements at the end of the intervention. The seven other studies had an increase in BMI from baseline to final measurements, but these changes were not necessarily abnormal taken natural bodily development for children and adolescents into consideration. Even if the changes at baseline and post intervention measurements on BMI is following normal development in most of the studies, I consider the inclusion of this parameter

is important to detect the differences between a intervention and control group. As earlier mentioned, Farpour-Lambert and colleagues focused on a sub-group which was obese, but in an intervention where all pupils are included, the obese ones are not measured separately. So my point is that, even if the changes are not positive revealing a stronger decrease in BMI for the intervention group versus those in the control, and if the BMI development are following normal growth standards, it should be considered positive from a obesity prevention point of view.

Regarding the prevention of obesity, one would expect that the recommendations regarding PA set by WHO would be highlighted throughout the implementation phase. Three out of eight studies in this review included different components in which the total time spent on PA during school hours would be enough to meet the recommendations of sixty minutes a day with MVPA. The participants in the remaining five studies spent from 33-75 minutes a day on PA, but they did not spend enough time on MVPA a day, to be sufficient to meet the recommendations.

Whereas the study of Ford et al (2013) did not meet the recommendations, I still considered the study to show a positive effect in terms of increase in PA. Hence, an intervention that provides a significant increase in PA, does not necessarily mean that it is sufficient to meet the recommendations set by WHO. A somewhat surprising finding in the study of Grydeland and colleagues (2013), was the intervention effect being stronger among those normal weight than those being overweight. This resulted in a greater distance between the active group and the less active group, since they did not increase as equally much. This was also a trend in the review of Lai et al (2014), where the obese participants reportedly had the smallest increase in total PA from baseline to post intervention in their included studies. Taken into consideration that the intervention of Farpour-Lambert et al (2009) provided positive changes and only included obese children, it is tempting to suggest that future interventions aimed to prevent and reduce obesity

and increase total level of PA should only include obese children and adolescents. I will not draw those conclusions and generalize based on one included study, but such an approach might provide positive changes in an effective way for this sub-group. However, both the reviews from Kriemler et al (2011) and De Meester et al (2009), emphasize the importance of including the general population of a class or school within a school-based interventions. From a psychosocial point of view, this makes sense. Indeed, overweight and obese young people already are facing stigma and bullying because of their bodily shape, and if only applying this group for a PA intervention, one cannot rule out the possibility that it would only lead further stigmatization and creating an even greater gap between normal weighted persons and those overweight. I find the intervention of Farpour-Lambert and colleagues to be an effective way to implement an intervention, even though they only included obese children, the participants in that study followed standard curricula at school, and in addition they participated in an out of school obese prevention program. In the future, it should be possible to combine school-based and after school-based interventions, which include the general population of a class or a school and are able to offer extra PA sessions outside of the school, to a sub-group consisting of the overweight and obese participants. By doing so one might hopefully avoid stigmatization.

## **5.4 Assessing physical activity**

All of the studies included in my review assessed PA with objectively measurements, which was through a accelerometer. The main reason for why i ended up including objectively measurers in stead of subjective measurements, was based on the fact that accelerometers through a great number of studies have been proven as a more valid and reliable way to measure PA then through subjective assessments such as self-reporting or questioners (Sirard & Pate, 2001).

This is also based on the «Level of sophistication» figure by Ekelund (2013), which is a figure

ranging the different way to assess PA. This figure does also tells us that when the ease to assess pa is high, normally the accuracy goes the opposite way. Questionnaires and self-reports regarding PA have also been considered as valid and reliable ways of assessment, but what Kriemler et al (2011) points out in their review, is that through these subjective means, often the participants tend to overestimate their own performance. This is one of the reasons why I consider objective measurements to be more accurate than subjective ones. When conducting a school-based intervention among children and adolescents and by assessing their level of PA through accelerometers, I assume that the researches will obtain more accurate results this way, than through questionnaires. With an accelerometer, the data is saved on the device and trained personnel collects it when required, which can be at baseline and and post intervention. Regarding subjective measurements and when dealing with children and adolescents, I consider it to be more difficult to remember every activity and the duration of activities that have been completed throughout an intervention, than it is when measuring it through an accelerometer which remembers for you.

## **5.5 Strengths and Limitations**

This review is based on change in physical activity primarily including studies using objectively measured PA through accelerometer and BMI. As presented in the flowchart and in the method chapter, my literature search and the screening of the relevant studies resulted in an inclusion of 8 studies out of the 646 studies from the first search I conducted in the databases of both *PubMed* and *SportDiscus*. These eight studies were by my opinion the only ones that matched all of my inclusion criteria. If eight studies are enough for meeting the requirements for it to be defined as a valid and reliable review is open for debate, but my opinion is that it is possible to draw conclusions on whether my included studies proved to be effective or not. Another

limitation might be that I only included studies from two databases. However, the explanation for this was that I previous of my literature search, entered the library page of the Norwegian School of Sport science, and looked at the actual databases which the school had full access to full text documents in. Some of the other databases i could have chosen to search in was *Web of Science, PsycInfo, BioMed Central, European Database of Sport Science, Spolit and SveMed+*. Some of these databases could most likely have provided me with additional studies that could have been included. However, taken the time I had granted to complete the thesis into consideration, I felt confident that these two major databases was adequate, to provide me with the studies i needed. The use of BMI as one of the primary outcome measurements, is something I might had been able to exclude. This is based on what i have discussed in the previous chapter regarding that in a school-based intervention conducted on a general population, that most of the changes were non-significant.

One of the strengths that this review provides, are that the single studies have been conducted in different parts of the world. This gave me the opportunity to compare data between adolescents with different backgrounds and relationship towards PA. When including studies from more than one continent, you get the chance to look at the different trends regarding PA amongst the participants and also the different approaches of the ones responsible for conducting and implementing the different interventions. The fact that all of the included studies were RCT by study design and measured PA objectively roughly through the same type of accelerometer, did also made it easier to compare and summarize the effect of the different interventions. The duration of the included interventions lasted from 15 weeks to 28 months, which is considered to be of adequate length to be able to implants and conduct an effective intervention. This is based on the inclusion criteria of the studies included in the peer reviewed reviews of Kriemler et al



(2011) and De Meester et al (2009), which I think should be considered as satisfactory standards. I also consider the amount of participants in the different studies ranging from 44 (Farpour-Lambert et al, 2009) - 1440 (Andrade et al, 2014), to be sufficient as an assurance of quality regarding how many a school-based intervention should include.

## **5.6 Implications for future research and practice**

The need of effective PA interventions amongst children and adolescents are essential to slow down prevention of lifestyle diseases and the mortality rate linked to inactivity and sedentary behaviour. What this review adds, is that focusing on changing several health behaviours leads to a divided focus on each behaviour, which have shown to be equal to a less effective intervention. Future interventions for the youth population should focus more on the overall level of PA, by including the out of school environment even more. This is based on that this review shows that almost all of the included studies provided positive changes on behaviour during school hours, but only a few managed to achieve an increase of the overall level of PA. Future research should also be focusing even more on reaching out to everyone in a general population. The summarized results showed that the active became more active, and that the increase in PA for sub groups such as the overweight and obese population were not as great. As suggested in the discussion chapter, future interventions should be combined by an in and out of school approach, to be able to better embrace everyone. All of these suggestions will of course lead to more expensive interventions, but having in mind the mortality rate caused by inactivity and the enormous economic burden related to this behaviour, investing in the health of the youth population should not be question about money.

## **6.0 Conclusion**

Based on the findings in this review, the strongest evidence regarding what an effective school-based intervention should consist of is primarily a multicomponent approach with parental or family involvement. The preferred duration of an ideal intervention should exceed at least 3 months, and the total number of participants to be included, should be of sufficient enough size to be able to draw conclusions from it. Regarding the question concerning if a school-based intervention is effective or not, the summarized results of this review suggests that it is. But it depends on the methods and the approach of the staff that plans and implements the intervention.

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