

## Danish University Colleges

### **Body Composition and Cardiovascular Health in School-aged children. An evaluation of the health effects of sports schools in the Svendborg Project. A prospective study.**

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**This is a short version of my PhD thesis:**

**Body Composition and Cardiovascular Health in School-aged children. An evaluation of the health effects of sports schools in the Svendborg Project. A prospective study.**

**For a full version please contact [hklakk@health.sdu.dk](mailto:hklakk@health.sdu.dk)**

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## Preface

This thesis was performed at the Institute of Sport Science and Clinical Biomechanics, Faculty of Health Sciences, University of Southern Denmark, Odense. Clinical Professor, MD, Niels Wedderkopp and Professor Dr. Med. Lars Bo Andersen provided supervision.

Trygfonden, University College Lillebælt and University of Southern Denmark supported the studies included in this thesis.

### *Evaluation Committee*

Clinical Associate Professor Henrik Steen Hansen, Cardiology, Department of Clinical Research, University of Southern Denmark (chairman)

Professor Sigmund Alfred Anderssen, Seksjon for idrettsmedisinske fag, The Norwegian School of Sport Sciences, Oslo

Professor Bente Klarlund, Department of Clinical Medicine, Section of Orthopaedics and Internal Medicine, University of Copenhagen

## List of Papers

- I. Wedderkopp N, Jespersen E, Franz C, Klakk H, Heidemann M, Christiansen C, Moller NC, Leboeuf-Yde C: **Study protocol. The Childhood Health, Activity, and Motor Performance School Study Denmark (The CHAMPS-study DK).** *BMC Pediatr* 2012, **12**(1):128.
- II. Klakk H, Chinapaw M, Heidemann MS, Andersen LB, Wedderkopp N: **Effect of Extra Physical Education Lessons on Body Composition in School Children aged 8-13 years.** *BMC Pediatr* 2013, **13**:170.
- III. H Klakk, LB Andersen, MS Heidemann, NC Moller, N Wedderkopp: **Six Physical Education Lessons a Week – the effect on cardiovascular risk factors in School Children aged 6-13 years: The CHAMPS study-DK.** *Scand J of Public Health* , 2013;0:1-9.
- IV. H Klakk, A Grøntved, LB Andersen, MS Heidemann, NC Moller, N Wedderkopp: **Prospective association of adiposity and cardiorespiratory fitness with cardiovascular risk factors in healthy children.** Accepted for publication in “*Scandinavian Journal of Medicine & Science in Sports*” - epub ahead of print November 2013.

Thesis at a glance

	Study design	Sample and exposure	Methods	Aim	Conclusion
Paper I	Study protocol, Controlled prospective cohort study  The CHAMPS-study.dk	Children attending 2nd to 4th grade in 10 public schools, 6 sports schools (intervention) and 4 normal (control) schools, Four extra physical education (PE) lessons/week at sports schools.	Questionnaire Anthropometrics, blood pressure, blood samples, CRF, motor performance and Accelerometers	To describe The CHAMPS study-DK that aims to evaluate the effect of implementing 4 extra Physical Education (PE) achieved through a number of studies.	The main areas of interest were 1. life-style diseases 2. Bone health 3. Musculoskeletal problems, and 4. Motor performance.
Paper II	Experimental prospective cohort study	739 children attending 2nd to 4th 2008, follow up 2010  Four extra PE lessons at sports schools.	Primary outcome: Body Mass Index and Total Body Fat (TBF) percentage derived from DXA.	To evaluate the effect of four extra PE lessons/week in primary schools on body composition and weight status	Four extra PE lessons at school significantly improved prevalence of OW/OB. A larger effect of intervention was observed in children who were OW/OB or adipose at baseline.
Paper III	Experimental prospective cohort study	1218 children attending pre-school to 4 <sup>th</sup> 2008, follow-up 2010  Four extra PE lessons at sports schools.	Blood pressure blood samples Anthropometry, Cardiorespiratory fitness (CRF)	To evaluate the effect of six PE lessons on children’s CVD risk defined by a composite risk score	Four extra PE lessons at school can reduce children’s cardiovascular risk measured as a composite risk score.
Paper IV	Observational prospective cohort study	739 children attending 2nd to 4th grade schools 2008 – 2010.  Exposure was adiposity and CRF	Blood pressure blood samples Anthropometry, TBF% by DXA, CRF Questionnaire: Birth weight and parental education level	To examine the prospective association of three different measures of adiposity and CRF with CVD risk factors.	CRF and adiposity was linearly associated with CVD risk factor levels over the full spectrum. The association of CRF attenuated when adiposity was adjusted for.

## Dansk Resume

### Baggrund

I 2011 vurderede Verdens sundheds organisationen, WHO, at mere end 40 millioner børn under 5 år og 10% af verdens skolebørn var overvægtige. Udover at påvirke børnenes øjeblikkelige sundhed har overvægt i barndommen vist sig også at have konsekvenser for sundhed og sygdom i voksenlivet. Forskere og politikere bør derfor have særlig fokus på området, da det må anses som et stigende problem for folkesundheden. Fysisk aktivitet er vigtigt for børns velbefindende og naturlige vækst og anses for at spille en vigtig rolle i forebyggelsen af overvægt og fedme og relaterede sygdomme.

Danske skoler er potentielt effektive arenaer for sundhedsfremme og forebyggelse, da man her, uden at stigmatisere høj-risiko børnene, har adgang til størstedelen af børn i Danmark, uanset etnisk og socioøkonomisk baggrund. WHO har da også udpeget skoler som et særligt egnet område til fremme af øget fysisk aktivitet for børn og unge. Der er således gennem de sidste årtier foretaget en del skolebaserede studier for at fremme fysisk aktivitet og forebygge overvægt. Resultaterne af indsatserne har ikke ført til entydig konklusion. Særligt er der behov for nye fremadrettede og længerevarende studier, hvor både form, indhold og varighed af interventionen vurderes.

Denne afhandling er baseret på 4 videnskabelige artikler, som beskriver og evaluerer en sådan længerevarende indsats med mere idræt i skolen; Svendborg Projektet. Svendborg Projektet er et kommunalt tiltag i 10 folkeskoler i Svendborg Kommune. Tiltaget betyder at seks udvalgte skoler er blevet sports skoler og har øget deres obligatoriske antal idrætstimer fra 2 til 6 ugentlig lektioner. The Childhood Health, Activity and Motor Performance School study (CHAMPS study-DK) er navnet på det forskningsprojekt, der efterfølgende er blevet tilknyttet for at evaluere effekten af det kommunale tiltag.

### Formål og problemstillinger i afhandlingen

Det overordnede formål med afhandlingen er at evaluere effekten af de fire ekstra idrætstimer på børns nuværende og fremtidige sundhed.

Problemstillingerne er:

1. At beskrive ideen og designet for Svendborg Projektet og CHAMPS study-DK (paper I).

2. At evaluere effekten af fire ekstra idrætstimer om ugen i folkeskolen på børnenes udvikling af BMI, fedt procent og overvægts prævalens (paper II).
3. At evaluere effekten af fire ekstra idrætstimer om ugen i folkeskolen på børnenes udvikling af hjerte-kar-sygdoms risikofaktorer (paper III).
4. At undersøge betydningen af kondition og kropssammensætning (direkte og indirekte målt) for hjerte-kar-sygdoms risikofaktorer hos raske danske børn i alderen 7 til 11 år over en to års periode. Samt at undersøge betydningen af ændringer i kondition og kropssammensætning i samme periode (paper IV).
5. At komme med anbefalinger for fremtidig forskning og folkesundhedstiltag på baggrund af de observerede resultater.

### Metode

Dette studie er baseret på data fra ovennævnte longitudinelle studie i 10 folkeskoler, seks intervention og fire kontrol skoler. Interventions skolerne indførte fire ekstra idrætstimer om ugen, mens kontrol skolerne fortsatte med de sædvanlige to idrætstimer om ugen. I 2008 blev i alt 1507 børn (intervention n=773, kontrol n=734) fra børnehaveklasse til fjerde klasse inviteret til at deltage i forskningsdelen CHAMPS study-DK. 81% af børnene og deres forældre valgte at deltage. Højde, vægt, talje omkreds, kondition, blodtryk, pubertets status og fedtprocent blev målt og blodprøver gennemført i 2008 og 2010. Information om forældrenes uddannelse, indkomst og børnenes fødselsvægt blev indsamlet med spørgeskemaer i løbet af det første skoleår.

### Resultater

Interventionen havde en gavnlig, omend ikke statistisk signifikant, effekt på gennemsnittet af BMI og fedt procent. Denne effekt var endnu større hos de børn, der var overvægtige ved start. Andelen af overvægtige og fede børn var signifikant lavere på interventions skolerne efter 2 år med mere idræt i forhold til kontrol skolerne. Idrætstimerne havde også en positiv effekt på en samlet hjerte-kar-sygdomsrisikofaktor score og de fleste enkelt risikofaktorer. Størrelsen af børnenes BMI, talje omkreds og fedtprocent ved start havde en lineær sammenhæng med niveauet af hjerte-kar-sygdomsrisikofaktorer efter to år. Denne sammenhæng blev svækket, men forsvandt ikke, når vi justerede for børnenes kondition, som også havde en lineær sammenhæng med risikofaktorerne.

### Konklusion

Evalueringen af Svendborg Projektet viser, at indførelsen af fire ekstra idrætstimer om ugen i folkeskolen kan forbedre børnenes sundhedstilstand i form af mindre grad af overvægt og fedme, samt ved at bremse udviklingen af hjerte-kar-sygdomsrisikofaktorer. Særlig stor effekt sås hos de børn, som havde mest behov: dem med den højeste BMI, fedtprocent eller risiko profil ved start. Den lineære sammenhæng mellem hjerte-kar-sygdoms risiko faktorer og børnenes kropsmål og/eller kondition peger på, at en hvilken som helst ændring til det bedre i BMI, talje omkreds, fedt procent eller kondition hos børn vil være gavnlig for folkesundheden. Således viser evalueringen af Svendborg projektet, at indførelsen af seks ugentlig idrætstimer er en effektiv strategi til forebyggelse af senere livsstilssygdomme hos børn.

## English summary

### Background

In 2011 the World Health Organization (WHO) estimated that more than 40 million children under the age of five were overweight and ten per cent of the world's school aged children are estimated to carry excess body fat. Childhood obesity is associated with a number of immediate cardiovascular health consequences and linked to subsequent morbidity and mortality in adolescence and adulthood. The issue is of growing concern for public health and therefore an important area for health researchers to address. Physical activity is essential for the wellbeing and normal growth of children and youth and plays an important role in the prevention of overweight and obesity and related morbidities.

Schools are recognized as potentially effective settings for public health initiatives, as they access a large population of children and youth across a variety of ethnic and socioeconomic groups without stigmatizing specific subgroups of high-risk children. The WHO specifically identified schools as a target setting for the promotion of physical activity among children and youth. During the last decades a considerable number of school-based, physical activity promotion and overweight prevention studies have been conducted, and their effectiveness on health outcomes evaluated. However, design and methods of these school-based studies differ, and results are not univocal, and more research is required on duration and volume of interventions in large-scale cohorts with long term follow up.

This thesis consists of 4 articles describing and evaluating a natural experiment, The Svendborg Project, in 10 public schools in the Municipality of Svendborg, Denmark. The experiment focused on increasing the amount of mandatory physical education (PE) lessons from two to six lessons per week. The Childhood Health, Activity and Motor Performance School study (CHAMPS study-DK) is the scientific research part of the Svendborg Project evaluating the initiative.

### Purpose and objectives of the thesis

The overall aim of this thesis is to evaluate the effect of four extra PE lessons in primary school (pre-school to 6<sup>th</sup> grade) on health related outcomes in children.

The objectives are:



1. To describe the Svendborg Project and the CHAMPS study-DK (paper I).
2. To evaluate the effect of four extra PE lessons per week in primary schools on body composition and weight status in children aged 8 to 13 (paper II).
3. To evaluate the effect of four extra school-based PE lessons per week on future cardiovascular disease (CVD) risk factors in children aged 6 to 13 (paper III).
4. To examine the prospective associations of cardio respiratory fitness (CRF) and direct and indirect indicators of adiposity with CVD risk factors in apparently healthy Danish children 7-11-years followed over 2 years. Furthermore, to examine the association of change in adiposity and CRF with change in CVD risk factor levels during follow-up (paper IV).
5. To recommend directions for future research and public health initiatives based on the results.

## Methods

This study is based on prospective data from 10 public schools, six intervention and four control schools matched according to the uptake area of the schools and socio-economic position of the parents. Intervention schools provided four additional PE lessons per week, where as control schools continued as usual (two PE lessons per week). A total of 1507 children (intervention n=773, control n=734) attending pre-school to the 4<sup>th</sup> grade in 2008 were invited to participate in the CHAMPS study-DK and 1218 (81%) children and their parents accepted. Height, weight, waist circumference, DXA scans, Cardio respiratory fitness (CRF), blood pressure, pubertal stage and fasting blood samples were obtained at baseline (2008) and follow-up (2010). Information on parental education level, household income and birth weight were collected from questionnaires during the first school year.

## Results

Intervention had beneficial, but non significant effect on mean BMI or mean Total Body Fat percentage (TBF%), but a significant beneficial effect on overweight and obesity prevalence, as children at intervention schools had a significant reduced risk of becoming overweight or obese after 2 school years compared to children at control schools. Also composite risk score and most single risk factors for CVD changed significantly more in favour of children attending intervention schools compared to children attending control schools. Baseline adiposity was independently and

positively associated to increased composite CVD risk score after 2 years. Adjusted for CRF this association attenuated, but stayed significant and independent. The associations were linear across the entire distribution of adiposity and CRF.

### Conclusion

Evaluation of this natural experiment showed that six PE lessons per week significantly changed prevalence of overweight and obesity after two years, also mean BMI and TBF% improved in intervention schools, though not significantly different from control schools. CVD risk factors significantly decreased in intervention schools compared to control schools. The intervention had a larger effect in children who were overweight and obese, or had the highest (over median) CVD risk scores at baseline. The shape and magnitude of associations of adiposity and CRF with CVD risk factors, suggest that any effort to shift the population distribution of adiposity downwards would be valuable for early CVD prevention in primary school children.

Overall, results support that a simple and relatively easily adaptable intervention, like the Svendborg Project, has the potential to positively affect future public health.