

# What makes children learn how to swim? – Health, lifestyle and environmental factors associated with swimming ability among children in the city of Malmö, Sweden

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## Research article

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# Abstract

## Background

Swimming ability among children in the city of Malmö, Sweden is strongly affected by socioeconomic differences. We investigated to what extent mediating health and lifestyle factors, such as children's eating, sleeping and physical activity habits, as well as the characteristics of the social and working environment at both school and home, could explain the socioeconomic gradient in swimming ability.

## Methods

Our study population included children who started their first-grade school-year in 2012 or 2013 at any of the public primary schools of Malmö, Sweden. Cross-sectional, self-reported questionnaire-based data about health status and swimming ability in the fourth grade (age 10) were included from the Pupil Health Database (ELSA) for 3,468 children.

## Results

Children's self-reported swimming ability was strongly associated with both individual- and school-based sociodemographic variables. Nine health, lifestyle and environmental variables were identified as potential mediators and included in the final model. Four of these variables, "Activity", "Outdoor time", "Social relationships at home and on the free time", and "Positivity about future", were significantly and positively associated with children's ability to swim.

## Conclusions

Social support, optimism for the future and an active lifestyle were positively associated with children's swimming skills; however, compared to the socioeconomic factors, these health- and lifestyle factors contributed very little. It is possible, that interventions concerning children's swimming ability in lower socioeconomic neighbourhoods, should in addition to children's swimming lessons, target the whole families with the goal of increasing their possibilities for socialising and engaging in different kinds of recreational activities.

## Background

Swimming is a potentially life-saving skill and learning to swim in an early age may reduce the numbers of children drowning [1, 2]. Swimming education in Sweden is part of the primary school curriculum and passing a swimming test is one of the requirements for being approved in the health and physical education course of the school years six and nine [3]. To pass the obligatory swimming tests at primary school, children in Sweden have to be able to swim continuously for 200 meters, of which at minimum 50 meters on backstroke [4]. Failing the swimming test in ninth grade may result in incomplete school grades and have a negative impact on the individual's chances to enter upper secondary school programmes.

Despite it being part of the school curriculum, large differences in swimming ability in children exist between different Swedish municipalities, with low swimming ability being more common in areas with a high proportion of families with a low socioeconomic status and immigrant background [4–6]. According to a case analyse of all child-drownings in Sweden, between 1998–2007, children from single parent families and with immigrant background had a higher risk of drowning than children with Swedish origin and from two parents families [7]. In a recent article, Pilgaard et al 2019 [4] investigated whether the introduction of a community-level swimming intervention program in public primary schools, year 2014 in the city of Malmö, Sweden, improved the swimming ability among children with poor socioeconomic status. Prior to this intervention, the swimming ability among children in Malmö was known to differ markedly between areas with different socioeconomic status, varying from 27% in Rosengård – a socioeconomically disadvantaged area, to 93% in Limhamn-Bunkeflo – the highest-ranked socioeconomic area in the city [5]. Pilgaard *et al.* found that the intervention introduced in the second grade did not decrease the socioeconomy-related differences in children’s swimming ability in the fourth grade, at least not in the first cohort exposed to the intervention based on the self-reports [4].

The process of learning to swim is presumably, like any other kind of learning, strongly affected by personal motivation [8]. Many variables, from social/environmental conditions to personal habits and internal thoughts and processes, can influence or alter a person’s motivation. According to previous literature, intrinsic motivation (often summarized as “fun” by children and youth), is the most influential factor in children’s desire to learn or participate in sports, while the extrinsic factors (i.e. achievement status, winning, pleasing parents or coaches) play generally less role as motivators [9–12]. However, intrinsic motivation does not develop independently in the child, and several external factors, such as the behaviour of the significant others (i.e. parents, relatives, good friends) can have a marked impact on children’s intrinsic motivation [10, 13]. Previous studies have reported that if children understand that sports are beneficial for health, they are more willing to participate and that children from high and medium socioeconomic backgrounds recognise more physical activity benefits than children from low socioeconomic backgrounds [14–16]. Generally, children from low socioeconomic backgrounds also experience less parental support and encouragement for physical activity than children from middle and high socioeconomic homes [15].

In the present study, we investigated to what extent certain mediating factors could explain the observed socioeconomic differences in learning how to swim among children. Among these factors were, for example, self-reported eating, sleeping and physical activity habits, as well as the characteristics of the social and working environment at both school and home. We hypothesised that variables that are generally associated with well-being, such as regular eating and sleeping habits, interest in sports and outdoor activities, active social life and general comfort at both school and home, would increase the swimming ability of children in the fourth grade.

## Methods

### *Study Population*

This study included children who started their first-grade school-year either in August 2012 or in August 2013 at any of the public primary schools of Malmö, Sweden. Cross-sectional, self-reported questionnaire-based data about the health status and swimming ability in the fourth grade (2015/2016) were obtained from the Pupil Health Database (ELSA) with an initial sample size of 4,242. We excluded those who were born outside Sweden (n=708) to restrict the sample to those who have had the opportunity to learn swimming in Sweden. An additional 62 children with missing data on their swimming ability, and four children that were attending a school for autistic children were excluded. That left 3,468 children as the final study cohort.

## Data collection

In Malmö, health examinations are offered to all children in preschool and in grades 4, 7 and 8 in primary schools. Since the school year of 2015/2016, school nurses enter anonymized data from health examinations at public schools (75% of all schools of Malmö) into ELSA database. For the present study, self-reported data regarding health and socioeconomic status and swimming ability (questionnaire statement “I can swim 200 meters”, answer “yes” or “no”) were retrieved from the ELSA database for the children in their fourth grade. In addition, we used a school-specific socioeconomic index (School Deprivation Index, SDI), which is regularly calculated by Statistics Sweden, and is based on following data for children at each of the schools: sex, years since arrival in Sweden (if immigrated), education of the parents, if the parents are receiving public income support, and family composition.

## Pooling and scoring of the questionnaire data

Individual-level sociodemographic variables, including participants’ family composition, parental country of origin and profession, were combined into one “Social Prerequisite Index” (SPI) (Table 1S. in Supplementary Material shows the variables and scores included into calculation of the SPI. Fig. 1S.a. in Supplementary Material displays the distribution of the variables that were pooled as SPI in relation to the probability of being able to swim). Responses to 46 questions related to health and wellbeing, retrieved from the ELSA database, were pooled into 14 potential mediator-variables by categorizing the questions according to the topics of: Eating habits, Sleeping habits, Activity level, Outdoor time, General wellbeing at school, Satisfaction with school’s physical environment, Satisfaction with school’s work environment, Satisfaction with social relations at school, Satisfaction with social relations at home, Self-satisfactions, Physical health and Negative emotions, (see Table 2S. in Supplementary Material for detailed information about the original questions included in each score). Responses to two of the statements in the questionnaire: “I am feeling well” (possible responses: “every day”, “most of the time”, “seldom”, “never”) and “My future looks bright” (possible responses: “very”, “somewhat”, “not much”, “not at all”), were estimated to weigh more than other responses and were thus evaluated as individual variables (named as “General wellbeing” and “Positivity about future”). The list of all considered mediator-variables is displayed in Table 1.

## Statistical analysis

Swimming ability (1= able to swim 200m, 0=not able to swim 200m) was used as binary outcome variable and the interquartile levels of the SPI and SDI calculated among all included children as exposure variables. Background characteristics of the study population and crude associations between variables are shown in Table 1.

To identify potential mediator variables among the pooled health and wellbeing scores, we first explored associations between the exposure-variables (SPI and SDI) and each of the 14 pooled score variables and in linear regression analyses (Table 2S.a). Thereafter, associations between each pooled score and the outcome variable (swimming ability) and were investigated, by using logistic regression models, with adjustment for exposure variables (SPI and SDI) (Table 2S.b). Only variables associated with both the exposure and outcome at 10% statistical significance level were included in further analyses (additionally adjusted for sex). Using the more traditionally used 5% level could fail to identify important covariates, as argued by Bursac *et al.* [17]. In the final model (Model A, in Table 2), interactions between swimming ability and exposure- and mediator-variables were analysed by multivariable logistic regression model by using Stata 14. In Model B associations between swimming ability and exposure variables (SPI and SDI) only were analysed by multivariable logistic regression model. Post-estimation statistics were used to estimate the goodness-of-fit of the models.

## Results

Background characteristics of the study population are depicted in Table 1. Similar proportion of girls (78%) and boys (77%) reported that they were able to swim 200 m. Individual- and school-based sociodemographic variables (SPI and SDI) were strongly associated with children's' self-reported ability to swim in both Model A and Model B (Table 2, see also Fig. 1S for a graphic depiction in the Supplementary material). Nine health- and wellbeing-related variables were identified as potential mediator-variables and included in the Model B (Tables 1 and 2). Of these variables the scores for "Activity", "Outdoor time", "Social relationships at home and on the free time", and "Positivity about future" were significantly and positively associated with the ability to swim (Table 2). Variables related to school environment ("Mental wellbeing at school", "Work environment at school", "Social relations at school") and the individual eating and sleeping habits ("Eating regularity score", "Sleep score") were not associated with swimming ability in Model B. Post-estimation analyses found the sensitivity of the Model B (only including sociodemographic exposure variables) to be 94.68%, the specificity 18.77%, and the percentage of correct classification 77.65%. In comparison the sensitivity of Model A (including both sociodemographic and health- and wellbeing- related variables) was 94.50%, the specificity 24.04% and the rate of correctly classified cases 78.69%. Likelihood-ratio test after-estimation of Model A and Model B indicated a significant difference between the models (LR chi<sup>2</sup> = 135.71; P < 0.001), thus indicating a better goodness of fit by model B.

## Discussion

Several factors that potentially mediate swimming ability in children of Malmö were investigated in the present study. The strong influence of socio-demographic characteristics, on both individual and school level, was evident. Among the behavioural- and lifestyle factors, scores for “Activity”, “Outdoor time”, “Social relationships at home and on the free time”, and “Positivity about future” were found to affect the relationship between socioeconomic variables and children’s swimming ability. Including both sociodemographic and health- and wellbeing-related variables, appeared to increase the fit and the percentage of correctly classified estimates in our statistical model, compared to when only sociodemographic variables were included to the model. However, the difference between models was marginal, and striking associations between individual- and school-level sociodemographic condition and swimming ability remained even after the health- and wellbeing-related factors were taken into account.

Behavioural theories, such as the Social Cognitive Theory and the Ecological Model, emphasize that health behaviours, including various physical activity skills, are not only determined by physiological and genetic characteristics of an individual, but also by socio-environmental factors, such as knowledge, self-efficacy, motivation, interpersonal relationships and possible barriers (i.e. being able to get to the location of physical activity) [18–20]. Swimming ability has been previously reported to be strongly influenced by whether the children have a parent or friends that can swim if they have knowledge of water-safety and are encouraged to swim, and if they have swimming facilities nearby [20].

Our score of “Social relationships at home and on the free time”, consisting of responses to three statements (“I like my home”, “I have friends outside the school”, and “I have an adult to talk to about important things”) was a possible indicator of children’s perception of their home environment and support network. Feeling secure and having support from one’s family, has been previously reported to be fundamental to any kind of learning processes, as well as a promotor for physical activity [21–25]. Children who felt supported by their families and friends in the present study were thus both expected and found to have higher odds of being able to swim than children without a supportive background.

The score of “Activity” was based on the responses to four questionnaire statements: “I am actively participating in physical activity (PA) lessons at school”, “I bike or walk to school”, “I am doing sports and moving a lot in my spare time”, and “I have free time hobbies (e.g. scouts, music, fishing, reading, etc.)”. Since positive responses to all these statements reflect high motivation for physical activity, experience in learning new skills and a generally active lifestyle, it was not surprising to find a significant positive relationship between this score and children’s ability to swim. Similarly, positive responses to the statements included in the “outdoor time score” (“I’m outdoors during the breaks” and “I am often outdoors after school”), are likely to reflect an individual’s habit of regular physical activity and an active lifestyle [26]. Self-efficacy – defined as “an individual’s belief in his/her capabilities to successfully execute necessary courses of action to satisfy situational demands” – has in previous literature been repeatedly identified as one of the most important factors to influence one’s will to exert and success in sports, and also, as a personal characteristic that may grow with regular physical activity [27–30]. Scoring high in “Activity” and “Outdoor time” may thus reflect and be associated to increased confidence

in children about their motor capacity, which in its turn, is likely to increase an individual's success in acquiring additional motor tasks, such as swimming ability [31].

Participants who selected "future is looking bright" ("Positivity about future") choice had higher odds of being able to swim 200 m than those who did not agree with the statement. This finding was not surprising since expectations regarding personal abilities and future outcomes are central to the formation of human behaviour and strongly affect motivation to learn new skills [8, 31, 32]. A positive view of one's future requires a positive appraisal of one's current situation or a strong belief that things are going to become better. For being able to maintain such beliefs, however, a person needs both a sense of personal capability and a positive evaluation of the social environment providing the necessary support [33]. Regular participation in physical activity has been reported to reinforce the feeling of internal capability in children and leads to an increase in optimism towards a successful life [34].

The strengths of the present study were the availability of data on sociodemographic factors both at the individual and the school level and the relatively large sample included. In addition, the participation in the health examinations entered in the Pupil Health Database was high, which limited the risk of selection bias. However, using self-reported data and a cross-sectional study design were significant limitations of our study. Since no documented school grades concerning swimming ability were available, it is possible that some children may have over- or underestimated their swimming skills. However, it is reasonable to assume that the misclassification regarding over- and underestimation of one's swimming ability was non-differential. There is also a potential for reverse causality since individuals who can swim, maybe generally more active which may result in increased wellbeing and positivity. A prospective cohort study, also including data on attitudes towards swimming as well as engagement and swimming ability among the parents, would elucidate drivers as well as barriers to swimming ability among children further.

## Conclusions

Socioeconomic factors are strongly associated with children's swimming ability. Lower socioeconomic status at both individual and school level is associated with lower odds of swimming ability among children. While most of the sociodemographic gradient in swimming ability remained unexplained in our study, social support, optimism for the future and an active lifestyle, however, were associated with sociodemographic conditions and also positively associated with children's swimming skills. Interventions should thus, in addition to children's swimming lessons, target the whole families with the goal of increasing their possibilities for socialising and engaging in different kinds of recreational activities especially in lower socioeconomic neighbourhoods. Swimming, as an activity has many positive health effects, both physiological and mental. Learning of these benefits may influence children's will to acquire swimming skills. Having "fun" (defined as a positive mood state related to personal achievement and perceptions that their skills are matched against realistic challenges) is, however, the most commonly reported intrinsic motivator by children and youth for participating in different kinds of sports and should therefore be in focus when designing the interventions. Our findings can be used to

target groups of children both at individual- and school-level with greater needs for support in swimming training.

## Abbreviations

CI	Confidence Interval
ELSA	the Pupil Health Database ( <i>Elevhälsodatabasen</i> )
IQL	Inter-Quartile Level
OR	Odds Ratio
PA	Physical Activity
SDI	School Deprivation Index
SPI	Social Prerequisite Index

## Declarations

## Ethics approval and consent to participate

This study was approved by the Regional Ethics Review Board of Lund, Sweden: Protocol 2017/7

## Consent for publication

All authors have given their consent for publication

## Competing interests

We have no competing interests

## Funding

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# Author contributions

Data collection and data base set up – POÖ, AO, SK

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## Tables

Table 1. Background characteristics of the study participants. Odds Ratios (OR), with confidence intervals (CI) on 95% level are shown for univariate associations between self-reported ability to swim 200 m (“yes” or “no”) and each variable

Variable name	Not able to swim 200m (N = 778)	Able to swim 200m (N = 2,690)	or (95%CI)
<b>Sex, n (%)</b>			0.94 (0.80, 1.10)
Female	377 (48)	1,344 (50)	
Male	401 (52)	1,346 (50)	
<b>Social Prerequisite Index (IQL), n (%)</b>			2.28 (2.08, 2.50)
very high	71 (9)	781 (29)	
high	126 (16)	853 (32)	
low	219 (28)	622 (23)	
very low	362 (47)	434 (16)	
<b>School-level Deprevalation Index (IQL), n (%)</b>			0.52 (0.48, 0.57)
very low	102 (13)	763 (28)	
low	100 (13)	752 (28)	
high	200 (26)	667 (25)	
very high	376 (48)	508 (19)	
<i>pooled health- and wellness scores divided at 50<sup>th</sup> precentile</i>			
<b>Activity score, n (%)</b>			1.31 (1.25, 1.36)
low	483 (62)	1,040 (39)	
high	295 (38)	1,650 (61)	
<b>Outdoor time score, n (%)</b>			1.52 (1.41, 1.64)
low	353 (45)	694 (26)	
high	425 (55)	1,996 (74)	
<b>Eating regularity score, n (%)</b>			1.39 (1.30, 1.49)

Variable name	Not able to swim 200m (N = 778)	Able to swim 200m (N = 2,690)	or (95%CI)
low	441 (57)	1,106 (41)	
high	337 (43)	1,584 (59)	
<b>Sleep score, N (%)</b>			1.08 (1.04, 1.13)
low	456 (59)	1,427 (53)	
High	322 (41)	1,263 (47)	
<b>Mental Wellbeing at school, n (%)</b>			1.24 (1.15, 1.31)
low	410 (53)	1,071 (40)	
high	368 (47)	1,619 (60)	
<b>Social relations at school, n (%)</b>			1.17 (1.11, 1.22)
poor	421 (54)	1,159 (43)	
good	357 (46)	1,531 (57)	
<b>Social relations outside school, n (%)</b>			1.32 (1.23, 1.41)
poor	315 (40)	751 (28)	
good	463 (60)	1,939 (72)	
<b>General Wellbeing score, n (%)</b>			1.07 (1.01, 1.13)
low	370 (48)	1,159 (43)	
high	408 (52)	1,531 (57)	
<b>Self-satisfaction score, n (%)</b>			1.07 (0.99, 1.15)
low	297 (38)	920 (34)	
high	481 (62)	1,770 (66)	
<b>Physical health, n (%)</b>			1.00 (0.98, 1.02)

Variable name	Not able to swim 200m (N = 778)	Able to swim 200m (N = 2,690)	or (95%CI)
poor	382 (49)	1,305 (49)	
good	396 (51)	1,385 (51)	
<b>Working environment at school, n (%)</b>			1.14 (1.11, 1.17)
poor	500 (64)	1,231 (46)	
good	278 (36)	1,459 (54)	
<b>School infrastructure satisfaction, n (%)</b>			1.05 (1.02, 1.08)
low	364 (47)	1,040 (39)	
high	414 (53)	1,650 (61)	
<b>Positivity concerning future, n (%)</b>			1.44 (1.2, 1.64)
low	324 (42)	824 (31)	
high	454 (58)	1,866 (69)	
<b>Negative emotion score, N (%)</b>			1.03 (0.99, 1.06)
high	370 (48)	1,207 (45)	
low	408 (52)	1,483 (55)	

Table 2. The estimated effect of health- and wellness-related factors mediator-variables on children's swimming ability in association with sociodemographic variables. Odds Ratios (OR) reflect the odds of reported ability to swim 200 meters (See also Fig. 1S). Model A. Association between swimming ability and sociodemographic exposures, adjusted for sex. Model B. Association between swimming ability and sociodemographic exposures, adjusted for health- and wellness-related factors and sex.

Domain	Variable	Model A, OR (95%)	Model B, OR (95%)
<b><i>Sociodemographic variables</i></b>	<b>Sex</b>		
	Female	1	1
	Male	0.93 (0.78, 1.10)	0.89 (0.75, 1.06)
	<b>Social Prerequisite Index (IQL)</b>		
	Very high	5.43 (3.82, 7.73)	4.11 (2.86, 5.92)
	High	3.15 (2.41, 4.12)	2.82 (2.14, 3.72)
	Low	1.55 (1.22, 1.97)	1.13 (0.83, 1.53)
	Very low	1	1
	<b>School Deprivation Index (IQL)</b>		
	Very low	2.41 (1.80, 3.23)	2.35 (1.74, 3.18)
	Low	2.66 (2.00, 3.53)	2.67 (1.99, 3.57)
	High	1.65 (1.33, 2.07)	1.65 (1.32, 2.08)
	Very high	1	1
<b><i>Health- and behaviour-related mediators</i></b>	Activity score		1.19 (1.13, 1.24)
	Outdoor time score		1.19 (1.08, 1.30)
	Eating regularity score		1.05 (0.93, 1.04)
	Sleep score		0.98 (0.93, 1.04)
	Mental wellbeing at school		0.97 (0.88, 1.07)
	Work environment at school		1.03 (0.99, 1.08)
	Social relations at school		0.93 (0.86, 1.01)

Social relations at home and during free time	1.10 (1.00, 1.20)
Positivity about future	1.22 (1.05, 1.42)

## Supplementary Material

Table 1s. Factors included in the Social Prerequisite Index (SPI).

Question	RESPONSE Alternatives				
<b>The child lives with...</b>	Both parents		Alternates between parents		Single parent or not with parents
scoring value	1		3		5
<b>The occupation of the parents</b>	Both non-manual labour	One non-manual one other	Both manual labour	One manual one not working	Both presently not working
scoring value	1	2	3	4	5
<b>The country of birth of the parents</b>	Both Swedish/Nordic	One Swedish/Nordic one other	One or both from rest of the Europe, North America or Australia	Both outside Europe, North America or Australia	
scoring value	1	2	3	4	
<b>IQL of the SPI scores</b> (min=3; max=14)	Very high	High	Low	Very low	
Range	3	4-6	7-8	9-14	

Table 2s. Description of the scoring method. The name of each new health- and wellness-related variable (1) and the questions included (column 2)



Question		How right is it in my case?			
Very	Some-what	Not much	Not at all		
<b>Eating Score</b>	I eat breakfast every morning	4	3	2	1
	I eat school lunch every school day	4	3	2	1
	I eat dinner/supper every day	4	3	2	1
<b>(min, max)</b>		12			3
<b>Sleeping Score</b>	It is easy for me to fall asleep in the evening	4	3	2	1
	I sleep well at night	4	3	2	1
	I feel rested when I wake up in the morning	4	3	2	1
<b>(min, max)</b>		12			3
<b>activity score</b>	I am actively participating in PA lessons at school	4	3	2	1
	I bike or walk to school	4	3	2	1
	I am doing sports and moving a lot in my spare time	4	3	2	1
	I have free time hobbies (e.g. scouts, music, fishing, reading, etc.)	4	3	2	1
<b>(min, max)</b>		16			4
<b>Outdoor time score</b>	I'm outdoors during the breaks	4	3	2	1
	I am often outdoors after school	4	3	2	1
<b>(min, max)</b>		8			2
<b>Wellbeing at school</b>	I feel calm and confident about going to school	4	3	2	1
	I like being at school	4	3	2	1
<b>(min, max)</b>		8			2
<b>School infrastructure satisfaction</b>	I like my schoolyard	4	3	2	1
	I think my school's toilets are clean	4	3	2	1
	I think the changing rooms and showers at school are functioning and clean	4	3	2	1
	I think the environment in the school canteen is good	4	3	2	1

Question		How right is it in my case?			
<b>(min, max)</b>		16			4
<b>School work environment score</b>	I can work in peace during the lessons	4	3	2	1
	I think the teachers listen to me	4	3	2	1
	I get the help I need at school	4	3	2	1
	I have no difficulties with school work	4	3	2	1
	I am happy with my school work	4	3	2	1
	I feel involved when decisions are made at the school	4	3	2	1
<b>(min, max)</b>		24			6
<b>School relations Score</b>	I have friends in school	4	3	2	1
	I think all the staff in the school are kind to me	4	3	2	1
	I think all students at school are kind to me	4	3	2	1
	I am friendly to all students and staff at school	4	3	2	1
<b>(min, max)</b>		16			4
<b>home and free time relations score</b>	I like my home	4	3	2	1
	I have friends outside the school	4	3	2	1
	I have an adult who I can talk to about important things	4	3	2	1
<b>(min, max)</b>		12			3
<b>Positivity About Future</b>	My future looks bright	4	3	2	1
<b>(min, max)</b>		4			1

	Question	How often does it happen?			
		Every day	Most of the time	Seldom	Never
<b>General Wellbeing</b>	I am feeling well	4	3	2	1
	(min, max)	4			1
<b>Self-satisfaction score</b>	I feel satisfied with myself	4	3	2	1
	I'm happy with my body	4	3	2	1
	(min, max)	8			2
<b>Negative emotion score</b>	I feel sad	1	2	3	4
	I feel worried	1	2	3	4
	I feel tired during daytime	1	2	3	4
	I feel annoyed or in a bad mood	1	2	3	4
	I feel angry	1	2	3	4
	(min, max)	5			20
<b>Physical health score</b>	I have a headache	1	2	3	4
	I feel dizzy	1	2	3	4
	I have stomach ache	1	2	3	4
	I have back, neck or shoulder pain	1	2	3	4
	I have pain in my hips, knees or feet	1	2	3	4
	I need medicine/drugs	1	2	3	4
	(min, max)	6			24

Table 2S. Exploratory statistics

a) Association between a possible single mediator and exposure variables (IQLs of social prerequisite index, SPI, and school deprivation index, SDI).

	SPI, $\beta$ (95% CI)	SDI, $\beta$ (95% CI)
<b>Activity</b>	0.35 (0.28, 0.43)	-0.07 (-0.14, 0.03)
<b>Outdoor time</b>	0.13 (0.09, 0.17)	-0.09 (-0.12, -0.05)
<b>Eating regularity</b>	0.25 (0.21, 0.30)	-0.10 (-0.14, -0.06)
<b>Sleep</b>	0.10 (0.31, 0.18)	0.02 (-0.04, 0.08)
<b>Mental wellbeing at school</b>	0.08 (0.03, 0.12)	-0.15 (-0.19, -0.11)
<b>School Infrastructure satisfaction</b>	0.18 (0.08, 0.29)	-0.30 (-0.39, -0.21)
<b>School relations</b>	0.24 (0.17, 0.31)	-0.21 (-0.27, -0.15)
<b>Home and free time relations</b>	0.15 (0.11, 0.20)	-0.02 (-0.06, 0.02)
<b>General wellbeing</b>	0.07 (0.01, 0.13)	0.01 (-0.04, 0.06)
<b>Negative emotions</b>	-0.06 (-0.17, 0.05)	-0.06 (-0.16, 0.03)
<b>Physical health</b>	0.09 (-0.07, 0.25)	0.11 (-0.02, 0.25)
<b>School work environment</b>	0.40 (0.28, 0.51)	-0.33 (-0.43, -0.23)
<b>Positivity about future</b>	0.03 (0.01, 0.06)	0.01 (-0.01, 0.03)
<b>Self-satisfaction</b>	0.04 (0.03, 0.10)	0.00 (-0.04, 0.04)

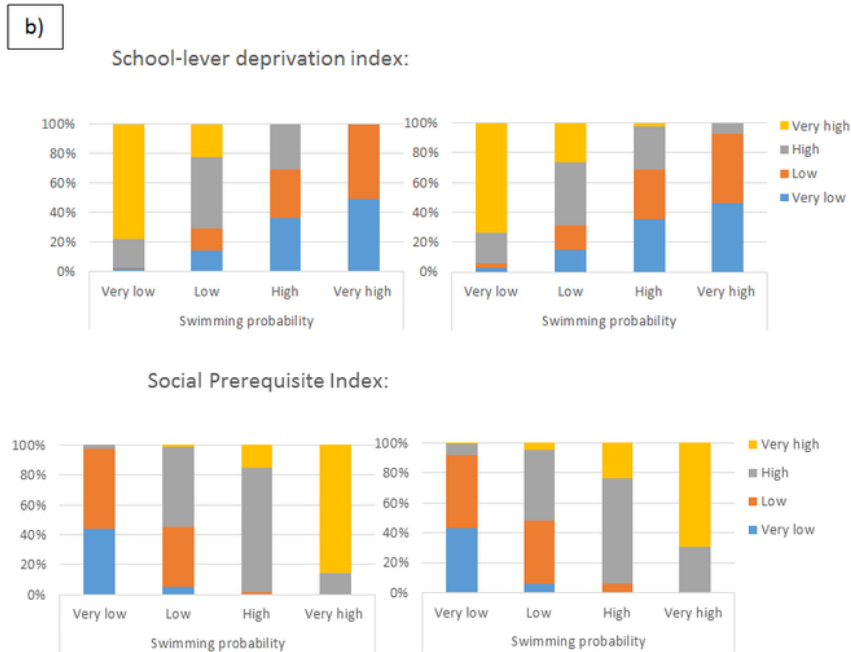
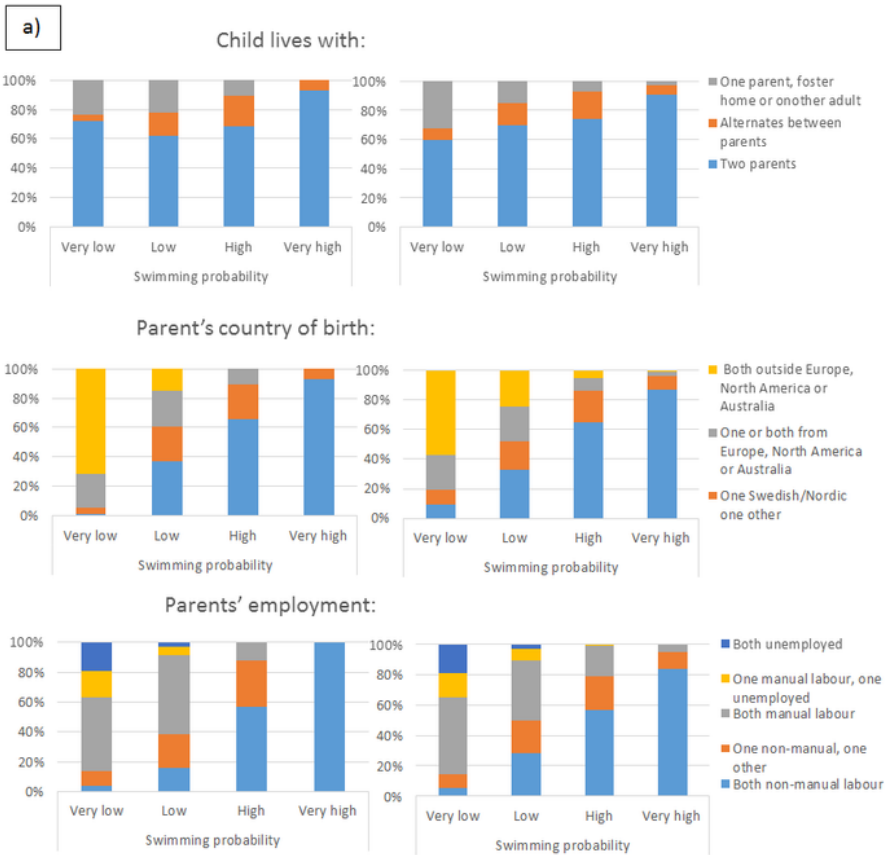
b) Association between outcome and a potential single mediator, adjusted for IQL of the exposure variables

	<b>Main, OR (95% CI)</b>	<b>SPI, OR (95% CI)</b>	<b>SDI, OR (95% CI)</b>
<b>Activity</b>	1.24 (1.19, 1.30)		
Very low		Ref	Ref
Low		1.52 (1.19, 1.95)	1.13 (0.84, 1.54)
High		3.00 (2.28, 3.93)	0.70 (0.53, 0.93)
Very high		4.31 (3.10, 6.33)	0.42 (0.31, 0.57)
<b>Outdoor time</b>	1.33 (1.23, 1.44)		
Very low		Ref	Ref
Low		1.46 (1.14, 1.87)	1.09 (0.81, 1.47)
High		2.96 (2.26, 3.89)	0.73 (0.55, 0.97)
Very high		4.93 (3.45, 7.03)	0.44 (0.33, 0.60)
<b>Eating regularity</b>	1.17 (1.09, 1.26)		
Very low		Ref	Ref
Low		1.51 (1.18, 1.92)	1.13 (0.84, 1.52)
High		2.92 (2.23, 3.83)	0.72 (0.54, 0.95)
Very high		4.90 (3.40, 6.94)	0.43 (0.32, 0.58)
<b>Sleep</b>	1.08 (1.03, 1.13)		
Very low		Ref	Ref
Low		1.53 (1.20, 1.95)	1.11 (0.83, 1.51)
High		3.09 (2.36, 4.04)	0.69 (0.52, 0.92)
Very high		5.29 (3.72, 7.53)	0.41 (0.31, 0.55)
<b>Mental wellbeing at school</b>	1.11 (1.03, 1.19)		
Very low		Ref	Ref
Low		1.55 (1.22, 1.98)	1.12 (0.83, 1.51)
High		3.14 (2.40, 4.11)	0.71 (0.54, 0.94)
Very high		5.34 (3.75, 7.59)	0.43 (0.32, 0.58)
<b>School work environment</b>	1.08 (1.05, 1.11)		
Very low		Ref	Ref

	<b>Main, OR (95% CI)</b>	<b>SPI, OR (95% CI)</b>	<b>SDI, OR (95% CI)</b>
Low		1.53 (1.20, 1.95)	1.14 (0.84, 1.54)
High		3.04 (2.32, 3.98)	0.73 (0.55, 0.97)
Very high		5.02 (3.52, 7.16)	0.44 (0.33, 0.60)
<b>School relations</b>	1.05 (0.10, 1.10)		
Very low		Ref	Ref
Low		1.54 (1.21, 1.96)	1.11 (0.82, 1.50)
High		3.10 (2.37, 4.06)	0.71 (0.53, 0.93)
Very high		5.26 (3.69, 7.49)	0.43 (0.32, 0.57)
<b>Home and free time relations</b>	1.22 (1.13, 1.31)		
Very low		Ref	Ref
Low		1.54 (1.21, 1.96)	1.63 (0.83, 1.52)
High		3.02 (2.30, 3.96)	0.55 (0.53, 0.92)
Very high		5.01 (3.52, 7.14)	0.23 (0.31, 0.56)
<b>Self-satisfaction</b>	1.04 (0.96, 1.12)		
Very low		Ref	Ref
Low		1.54 (1.21, 1.96)	1.10 (0.82, 1.48)
High		3.14 (2.40, 4.11)	0.68 (0.52, 0.91)
Very high		5.40 (3.80, 7.69)	0.41 (0.31, 0.56)
<b>Physical health</b>	1.01 (0.98, 1.03)		
Very low		Ref	Ref
Low		1.55 (1.22, 1.97)	1.10 (0.82, 1.49)
High		3.15 (2.42, 4.13)	0.69 (0.52, 0.91)
Very high		5.42 (3.81, 7.72)	0.41 (0.31, 0.55)
<b>School Infrastructure satisfaction</b>	0.99 (0.96, 1.03)		
Very low		Ref	Ref
Low		1.54 (1.22, 1.97)	1.17 (0.82, 1.48)
High		3.16 (2.42, 4.14)	0.68 (0.52, 0.90)

	<b>Main, OR (95% CI)</b>	<b>SPI, OR (95% CI)</b>	<b>SDI, OR (95% CI)</b>
Very high		5.45 (3.83, 7.76)	0.41 (0.31, 0.55)
<b>Positivity about future</b>	1.43 (1.25, 1.64)		
Very low		Ref	Ref
Low		1.55 (1.21, 1.97)	1.10 (0.81, 1.48)
High		3.13 (2.39, 4.10)	0.67 (0.51, 0.89)
Very high		5.30 (3.72, 7.54)	0.41 (0.30, 0.54)
<b>General wellbeing</b>	1.05 (0.99, 1.11)		
Very low		Ref	Ref
Low		1.55 (1.21, 1.97)	1.10 (0.82, 1.49)
High		3.14 (2.40, 4.11)	0.69 (0.52, 0.91)
Very high		5.38 (3.78, 7.65)	0.41 (0.31, 0.55)
<b>Negative emotions</b>	1.03 (1.00, 1.06)		
Very low		Ref	Ref
Low		1.55 (1.22, 1.98)	1.10 (0.82, 1.49)
High		3.19 (2.44, 4.18)	0.69 (0.52, 0.91)
Very high		5.45 (3.84, 7.76)	0.44 (0.31, 0.56)

## Figures



**Figure 1**

Groups based on the interquartile level (IQL) of the estimated probability swimming ability (1st quartile – “Very low”, 2nd quartile – “Low”, 3rd quartile – “High” and 4th quartile – “Very high”). Swimming probability groups were calculated based on models A. (left) and B. (right, see also Table 2). a) Distribution (%) of the variables included in “Social Prerequisite Index” (SPI) in the swimming probability



groups. b) Distribution (%) of IQL school-level deprivation index and IQL SPI within different probability groups