The relationship between fitness and health-related quality of life and the mediating role of self-determined motivation in overweight adolescents

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Aim: To examine the relationship between cardiorespiratory fitness (CRF) and health-related quality of life (HRQoL) among overweight adolescents and to test whether this relationship is mediated by body image (BI) and self-determined motivation for physical activity (PA) and exercise. *Methods:* 120 adolescents identified as overweight or obese were recruited through the school health service. The participants completed self-report instruments measuring HRQoL, BI and self-determined motivation for physical activity and exercise in addition to a 20-m shuttle-run test, and body mass index was calculated. Confirmatory factor analysis was conducted to evaluate the hypothesized five-dimensional structure of the Behavioural regulation in exercise questionnaire-2 (BREQ-2) used to measure self-determined motivation. Associations between the study variables were explored using univariate linear regression. Mediation was tested by a multistage regression approach. *Results:* The five-dimensional model of BREQ-2 showed acceptable fit for the data. We revealed a statistically significant association between cardiorespiratory fitness and HRQoL (4.16 [0.3-8.02]; $p < 0.05$). CRF failed to affect BI in the first mediation equation, hence body image was excluded from further analyses. However, self-determined motivation proved to mediate the relationship between CRF and HRQoL. *Conclusions:* The results of this study suggest that the motivational mechanisms related to fitness can contribute to explain the association between CRF and HRQoL in adolescents with overweight. The findings are important from a public health point of view and should be taken into account in the development of PA-interventions for adolescents with overweight and obesity for the potential enhancement of their physical and psychosocial well-being.

Key words: *Adolescents, overweight, cardiorespiratory fitness, health-related quality of life, self-determined motivation*

Introduction

A number of studies have shown that children and adolescents with overweight have lower health-related quality of life (HRQoL) than their normal weight peers [1, 2]. HRQoL can be defined as a multidimensional construct covering physical, emotional, mental, social and behavioural components of well-being and functioning as perceived by patients and/or other observers [3]. Among overweight youths, largest impairments in HRQoL are consistently documented in physical and social dimensions of HRQoL with increased risk of low self-regard, particularly in their perception of physical appearance and athletic competence [2]. Physical activity (PA) is found to be positively related while sedentary behaviour is negatively related to HRQoL in adolescents [4]. Overweight and obese adolescents are reported to be less physically active and less physically fit than their leaner peers, possibly due to lower participation in sport resulting in less moderate to vigorous PA [5, 6]. Because

of the limitations of subjective measure of PA, objectively measured physical fitness might capture more reliable data which again may explain why studies show an even stronger relationship between physical fitness and overweight than physical activity and overweight [6]. Gender differences in aerobic test performance are well documented. Males perform higher than girls at all ages [7]. However, there seem to be no difference in the relationship between overweight and fitness between genders as cardiorespiratory fitness (CRF) is shown to be inversely associated with BMI in boys and girls [8].

Knowing that overweight adolescents are found to be less fit while they also report lower HRQoL, supports the need of further investigation of *if* and *how* CRF might be related to HRQoL. Examination of psychosocial mediators can provide explanations to how restrictive physical resources (i.e. CRF) take on internal psychological significance [9], by influencing for example HRQoL. One factor that is known to influence perceived health and well-being among adolescents is *body image* (BI) [10]. Despite being limited, there is some research showing associations between lower levels of CRF and body dissatisfaction [11]. Another variable, which may contribute to explain a potential relationship between CRF and HRQoL, is *exercise motivation*. Self-determined motivation for PA and exercise as described in self-determination theory (SDT) has been found to be positively associated with both HRQoL and exercise behaviour in adolescents [12]. According to SDT, people can be intrinsically and extrinsically motivated as well as amotivated in their regulations towards PA and exercise. Amotivation implies not having any intention or energy directed toward action at all, intrinsically motivated activities are performed for the enjoyment of the activity in itself, while extrinsically motivated activities are performed in order to obtain an outcome separable from the activity [13]. Different forms of extrinsic motivation can be conceptualized along a continuum from non-autonomous, controlled forms of behavioural regulation (external and introjected regulations) to completely autonomous forms (identified and integrated regulations) [13]. Previous research in obese adolescents has documented a positive relationship between self-reported PA and a higher level of self-determined regulation of behaviour for exercise [14]. Whereas less is known about the associations between objectively measured CRF and autonomous motivation for this group, there is sound reason to believe that young people experiencing themselves as physically less fit are likely to perceive themselves as more externally regulated in their motivation to be active, even amotivated. There is evidence that autonomous reasons or participation motives for exercise reflecting extrinsic behavioural regulation is likely to decrease HRQoL indices such as well-being, whereas controlled reasons reflecting intrinsic behavioural regulation have been shown to be related to symptoms of ill-being which would be indicative of reduced HRQoL [15]. Form a clinical and public health point of view, there are good arguments for investigating the relationship between CRF and HRQoL variables as such knowledge can inform strategies for promoting PA and thus improving CRF and HRQoL among overweight adolescents.

The aim of this study was to examine the relationships between CRF, BI, self-determined motivation and HRQoL in overweight adolescents. We hypothesized that CRF was positively related to HRQoL and partly mediated by BI and self-determined motivation for exercise.

Methods

Participants and data collection

The data included in the present cross-sectional study were collected at baseline of a pilot intervention study aiming to increase PA among adolescents with overweight. School nurses in secondary schools in three counties in eastern Norway assisted in recruitment. Following routinely screening of height and weight in the eighth or ninth grade, adolescents with age- and gender adjusted body mass index (BMI) above 25 were invited to take part in this study. Adolescents involved in outpatient treatment programs or other interventions were not eligible. 120 adolescents from 29 different schools in both urban and rural districts, agreed to participate. Self-report instruments, measurement of height and weight and a standardized fitness-test were completed individually during school time. Written informed consent from both the adolescents and at least one of their guardians secured their rights. The data were collected and filed anonymously. The study was reviewed and approved by the Regional Research Ethics Committee of Norway.

Measures

Anthropometric measurements. Body weight was measured to the nearest 0.1 kg with a portable digital weight. The adolescents wore no shoes and only light clothing. Weight measurements were corrected (-0.5 kg) for clothes. Height was measured to the nearest 0.1 cm with a stadiometer. BMI (kg/m^2) was calculated based on weight and height measurements. The age and gender specific BMI cut-off values proposed by the International Obesity Task Force were used to categorize the adolescents as overweight or obese [16].

Health-related quality of life. The Norwegian version of the KIDSCREEN was used to assess HRQoL. KIDSCREEN is a generic instrument and focuses on physical, mental, and social dimensions of well-being, and measures HRQOL from the child's or adolescent's perspective [17]. For this study, we constructed a global HRQoL score based on an index from the 10 item version as described in the KIDSCREEN manual [17]. The raw scores were transformed linearly to a 0–100-point scale, with 100 indicating the best HRQoL and 0 the worst [17]. The Norwegian version of KIDSCREEN-10 has previously shown satisfactory validity and reliability [10]. A Cronbach's alpha of 0.79 indicated an acceptable internal consistency for the questionnaire in this study.

Cardiorespiratory fitness. The 20-meter shuttle run test (20-mSRT) was applied to measure aerobic fitness. This is a reliable and valid field test widely used to assess fitness in children and adolescents [18]. The test consists of running 20 m shuttles back and forth starting at a running speed of 8.5 km · h^{-1}. The pace continues to increase by 0.5 km · h^{-1} every minute thereafter. The test is over when a participant has to stop because of fatigue or fail to maintain the pace for two consecutive shuttles. In accordance with the literature, test performance was calculated and presented as total shuttle count and end running speed, of which the latter was included in the analysis [7, 19].

Body image. BI was assessed using a body image scale developed in Norway [20]. The scale consists of four items which were summed up to construct a BI score ranging from 0 to 20 with higher scores indicating a more positive BI. Previous research has found that the scale has acceptable reliability

(Cronbach's alpha 0.85) [21]. In this study, Cronbach's alpha for the scale was 0.87 showing good internal consistency.

Behavioural regulation in exercise. Motivation towards physical activity and exercise was measured using Behavioural regulation in exercise -2 (BREQ-2). The questionnaire has previously shown satisfactory validity when being tested on a sample of obese Dutch adolescents [14], but has not earlier been tested on Norwegian adolescents. Thus, we performed a translation-back translation and a factor analysis to confirm the structural model fit of the scale in which the 19 items were assigned to load on the five originally hypothesized first-order latent variables; *intrinsic regulation, identified regulation, introjected regulation, external regulation and amotivation*. In our version the term "exercise" was replaced with "physical activity *and* exercise" to emphasis the value of increasing PA in general, not only the shorter bouts of exercise (i.e "It's important for me to be physically active and exercise regularly"). A similar change was successfully made in the Dutch version of the questionnaire [14]. For examining our model, a relative autonomy composite score representing self-determined motivation was calculated consistent with past work [12, 22]. The score ranges from -24 to +20 with more autonomous motivation being indicated by higher positive scores.

Statistical analysis

Confirmatory factor analysis of the BREQ-2 was conducted using Mplus-version 7. The purpose was to test and evaluate how well our data fitted the hypothesized five-dimensional structure of the measure. Using the robust MLM-estimator to account for of non-normality of the data, the model fit was determined by the Satorra-Bentler scale corrected chi-square test, the Comparative Fit Index (CFI), the standardized root-mean-square residual (SRMR), the root-mean-square error of approximation (RMSEA), and the 90 % confidence interval around the RMSEA [23].

The Mann-Whitney-Wilcoxon test was applied to test for differences between genders and BMI status (overweight versus obese) and selected study variables. Associations between the study variables and the outcome variable HRQoL were explored using univariate linear regression. Mediation was tested by a multistage regression approach outlined by Baron and Kenny [9] in which three regression equations are estimated. In the first equation, the mediator is regressed on the independent variable (path a), in the second equation the outcome variable is regressed on the independent variable (path c) while lastly the outcome variable is regressed on both the mediator and the independent variable (path b+c). These regression equations provide the tests of linkages in the mediation model as depicted in Figure 1. P-values ≤ 0.05 were considered statistically significant. Due to the exploratory nature of our study, we did not correct for multiple testing. Except for the factor analysis, all remaining analyses were performed using SPSS© 20.0.

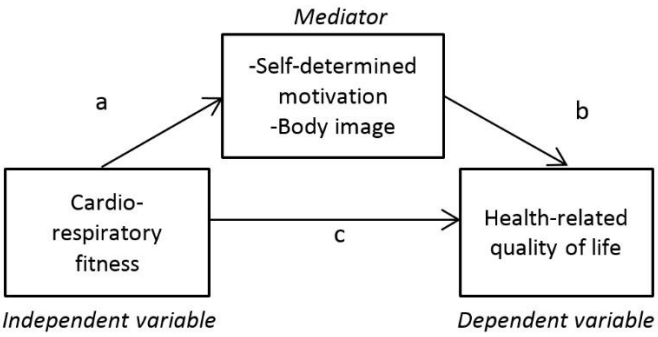

Figure 1 Path diagram of hypothesized associations between CRF and HRQoL and the potentially mediating effects of BI and self-determined motivation.

Results

Confirmatory factor analysis of BREQ-2

Overall the 19-item five-dimensional model showed an acceptable fit for the data, (S-B χ^2) = [df = 142, n = 101] = 190.220, p<.001; RMSEA = 0.06 [90% confidence interval around RMSEA = 0.03 to 0.08]; CFI = 0.94; SRMR = 0.07. Standardized solution of parameter estimates of the five subscales revealed that items were generally found to load strongly and significantly on their hypothesized latent factor thus reflecting dimensional validity between the latent factors. Standardized loadings, ranged from 0.51 to 0.90 on the five dimensions except for item 17 ("I get restless if I don't do physical activities and exercise regularly") which showed a low saturation of 0.28 with its factor (identified regulation). Reliability was confirmed by acceptable levels of Cronbach's alpha for all subscales: amotivation = 0.83, external regulation = 0.76, introjected regulation = 0.78, identified regulation = 0.71 and intrinsic regulation = 0.86.

Characteristics of the sample

As shown in Table 1, the sample of 120 included 73 girls and 47 boys. 80 were overweight and 40 obese. Data were generally skewed and therefore median values are given. Univariate analyses revealed no statistically significant differences in BMI, HRQoL and self-determined motivation between girls and boys, however CRF was, significantly higher in males than females. Females scored significantly lower on BI compared to boys. The obese adolescents were significantly less fit than those who were overweight, however there were no differences between the two groups with respect to HRQoL, BI or self-determined motivation.

Table 1 Characteristics of the sample and descriptive data on study variables

Variable	Total (n=120)	Female (n=73)	Male (n=47)	*Difference P* value	Overweight (n=80)	Obese (n=40)	*Difference P* value
Age (n=120)	13.73 (2.2)	13.69 (2.1)	13.77 (2.2)				
BMI (n=120)	26.78 (15.7)	26.9 (15.67)	26.4 (14.28)	0.385			
HRQoL (n=105)	67.5 (82.5)	65.0 (82.5)	70.0 (42.5)	0.159	67.5 (70.0)	67.5 (72.5)	0.975
CRF shuttles (n=120)	22.5 (58.0)	20.0 (37.0)	29.0 (57.0)	*<0.01*	24.5 (54.0)	15.5 (34.0)	*<0.001*
CRF running speed (n=120)	9.5 (3.5)	9.5 (2.5)	10.0 (3.5)	*<0.01*	10.0 (3.0)	9.25 (2.0)	*<0.001*
BI (n=114)	8.0 (19.0)	6.0 (16.0)	11.0 (16.0)	*<0.001*	8.0 (17.0)	7.0 (19.0)	0.765
SDM (n=116)	8.88 (30.33)	8.08 (28.33)	10.33 (22.17)	0.191	8.5 (20.0)	9.83 (30.33)	0.732

Values shown as median (range). BMI = body mass index; HRQoL = health-related quality of life; CRF = cardiorespiratory fitness; BI = body image; SDM = self-determined motivation

Associations between health-related quality of life and study variables

Univariate linear regression was applied to explore whether there was a linear relationship between the dependent variable HRQoL and selected independent variables. The results are presented in Table 2. The analysis showed a significant association between CRF and HRQoL (B=4.16). In addition, the analysis confirmed significant associations between the hypothesized mediators BI (B=0.74) and self-determined motivation (B=0.85) on HRQoL. BMI was not significantly associated with HRQoL. The sample was homogenous with respect to age, making it irrelevant to test for a possible association between age and HRQoL.

Table 2 Associations between HRQoL and study variables

Variable	B	95% CI	*P* value
CRF Running speed	4.16	0.3-8.02	*<0.05*
Body image	0.74	0.2-1.28	*<0.01*
Self-determined motivation	0.85	0.41-1.28	*<0.001*
Body mass index	-0.29	-1.08-0.49	0.458

HRQoL = health-related quality of life; CRF = cardiorespiratory fitness

Mediating effect of body image and self-determined motivation for physical activity and exercise

Because girls scored significantly lower on BI than boys did (Table 1), gender was controlled for when regressing BI on CRF in the first step in the first test for mediation. This revealed a non-significant relationship between BI and CRF. Performing the same analysis for boys and girls separately, continued to produce a non-significant result. Thus, the first condition for mediation did not hold and BI was excluded from further analysis.

However, when self-determined motivation was regressed on CRF we found a statistically significant relationship (B = 2.08; 95% CI [0.53-3.63]; $p < 0.01$). This indicated that adolescents, who were more fit were also more autonomously motivated for PA and exercise. The second step of the mediation analysis, involved regressing HRQoL on CRF. This relationship was confirmed by the univariate analysis as presented in Table 2. In the final step HRQoL was regressed on both CRF and the presumed mediator. All relationships are shown as unstandardized estimates of betas in Figure 2.

Together CRF and self-determined motivation explained 14,5 % of the variation in HRQoL. When adding self-determined motivation as mediator in the third step, the previously significant relationship between CRF and HRQoL was no longer significant (B =2.55; 95% CI [-1.27-6.36]; *p* = 0.189), indicating that self-determined motivation mediated the relationship between fitness and HRQoL. (The remaining relationship is presented in italic in Figure 2).

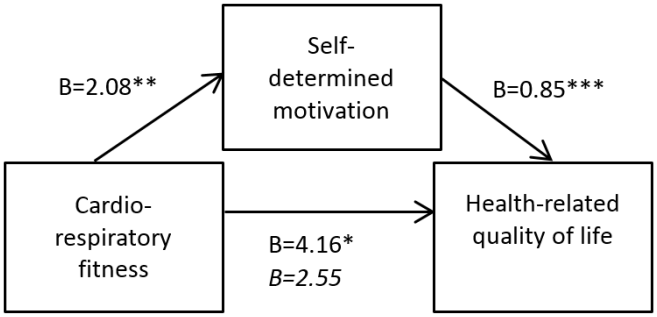

Figure 2 Model of mediated cardiorespiratory fitness
p <0.05; **p <0.01,*p <0.001*

Discussion

Initially in the current study, we performed an analysis to confirm the factor structure of the BREQ-2. Overall, the fit indices supported the model fit revealing also that generally all items contributed to the measurement of the respective hypothesized corresponding latent constructs, thereby supporting dimensional validity of all five dimensions of regulation of motivation. Nevertheless, item 17 showed a low loading. Similar findings have been reported in previous studies on adults [24, 25] as well as adolescents [14]. One possible explanation is that although the item is included in the identified regulation factor, the term “restless” reflects negative feelings and may thus be understood as referring to introjected regulation [25]. This assumption has been supported as item 17 is found to cross-load with the introjected subscale [14]. In the case of the present study, we also have to consider the participants' age. “Restless” is a term that is not often used, or perhaps experienced, by 13-14 year olds, at least not in the context of exercise. Low loadings may thus stem from inability to capture the meaning of the item. Arguments have been made by other researchers for exclusion of this particular item from the model [24, 25]. The sample size of the current study is too small for thorough investigation of the factor structure, and because the item in this case actually loaded on its intended factor, we decided to keep all 19 items in the calculation of the composite score.

The main contribution of the present study was to investigate the relationship between CRF and HRQoL among adolescents identified as overweight or obese and to gain increased knowledge about potential mechanisms relating to the two variables. Our hypothesis was partly supported by the findings. In this sample of adolescents with relatively low aerobic capacity and HRQoL [7, 10], our data revealed a significant, positive direct relationship between CRF and HRQoL. The fact that a generic short form instrument for measurement of global HRQoL managed to capture the contribution of CRF on overall HRQoL, may emphasize the importance of physical performance for

well-being in this group. Lack of studies presenting associations between fitness and HRQoL among adolescents makes it difficult to make comparisons. However, in a Spanish study including children with overweight, the authors found that both CRF and muscular fitness were closely related to HRQoL [26]. Trying to discover explanations for *how* CRF and HRQoL was related, we focused our attention to BI and self-determined motivation as possible mediators. Although body dissatisfaction is shown to be positively related to lower exercise rates in both boys and girls [27], we found no statistical significant relationship between CRF and BI when controlling for gender, indicating that gender and not CRF explained the variability in BI. Nevertheless, the idea that aerobic capacity may facilitate how an adolescent feels about his or her body, is worthy of further investigation in a larger sample.

Our data revealed that self-determined motivation at least partly mediates the relationship between CRF and HRQoL. Low statistical power may have affected our ability to conclude concerning the degree of mediation. Nevertheless, the findings suggests that it is not the physiological effects of being fit as much as the motivational mechanisms related to fitness that explains the association between CRF and HRQoL. Apparently, even among overweight adolescents, those physically more fit may perceive taking part in PA and exercise as more intrinsically reinforcing, in turn paving the way for benefitting from positive HRQoL effects of being active. Research confirming these findings is absent in the context of overweight adolescents. However, support for our results may be found in PA-research framed by SDT. According to SDT, satisfaction of the needs for autonomy, competence and relatedness nurture the development of more self-determined regulations which underpin both task persistence and psychological well-being [15]. Sustained vigorous activity and exercise are found to be positively associated with competence need satisfaction and introjected and identified regulations, while external regulations are negatively associated with strenuous exercise behaviour [28]. Thus, adolescents who are more autonomously regulated to engage in vigorous PA and exercise may experience increased fitness. However, the opposite, that fitness affects motivation, may just as well be the case. SDT posits that perception of competence is a function of the information used by individuals to judge their performance ability, and that this information stem from two main sources; external feedback provided by others and internal feedback received from the individuals' perceptions of his or her own performance [29]. Hence, perceiving oneself as fit may support a feeling of competence and foster increased intrinsic motivation, while being unfit causes feelings of incompetence leading to more external forms of regulation towards PA and exercise. Another important issue in the present context is how sport participation provides opportunities for social interactions. Adolescents report that being with friends is what is most important to their quality of life [30]. Having the physical capacity to participate in PA and sports together with friends may thus influence exercise motivation and subsequently HRQoL.

Several limitations to the study should be considered. Because of the convenience sample, the results presented in this study may not be generalizable. The participants were invited to take part in an intervention focusing on increasing PA. It is likely that they were more self-regulated in their motivation for PA and exercise than in the general population. The relative homogeneity and the small sample size may have hindered detection of important correlations, while also not providing sufficient power to analyse subgroups. Additionally a larger sample would make it possible to do a thorough validation of the BREQ-2 and to test our model by means of latent scores using a structural equation modelling approach. There are validity issues associated with the use of self-report measures. In addition, BMI is a disputed measurement of fatness, as it does not take full account of

maturation status. Despite limitations, there are valuable strengths of this study as few others have previously investigated the importance of self-determined motivation in relation to CRF and HRQoL in this, or in other populations. Further experimental designs have the potential to provide valuable insight into the causal direction of these associations.

Conclusion

This study adds to and extends previous limited research on association between CRF and HRQoL by showing that this relationship is mediated by self-determined motivation. From a public health point of view such knowledge is important and should be taken into account in the development of PA-interventions for adolescents with overweight and obesity, not only for the sake of increased metabolism to reduce weight, but also for the potential enhancement of physical and psychosocial well-being.

Acknowledgements

We thank the school health nurses who assisted in the recruitment process and our young participants who made this study possible.

Conflicts of interest

None declared.

Founding

The study was financially supported by the Norwegian Extra Foundation for Health and Rehabilitation through the Norwegian Women's Health Association and the Oslo and Akershus University College of Applied Sciences.

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