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Enlightenment and measurement – a way to improve health among high school students

Keywords: Health programme intervention; High school students; Obesity; Aerobic fitness; Well-being

Abstract:

This paper examines the effect of participating in a web-based health programme that promotes personal tracking of high school students' own measurements of a number of health-related parameters. Danish cross-sectional survey data were used to examine the effects of the health programme on various health measures. Both quantile regression models and standard ordinary least squares (OLS) models were used to explore the correlations between the students' participation in the health programme and their body mass index (BMI), body fat percentage, aerobic fitness and wellbeing. Participation in the health programme increased BMI and aerobic fitness among students with a BMI or an aerobic fitness value ranging from the 25^{th} percentile to the 75^{th} percentile and reduced body fat percentage among students with the highest percentages of body fat. In addition, the health programme led to an increased feeling of wellbeing among students, especially those with high BMI levels and poor aerobic fitness. As the schools participated in the health programme on voluntary basis and at a financial cost to themselves, the positive effects of participation found can only be stated to be valid among students from committed schools.

Introduction

Across most European counties, one in seven children are overweight or obese (OECD, 2010). Several countries and international organisations, such as the World Health Organization (WHO) and International Obesity Task Force (IOTF), have initiated health programmes aimed at preventing child and adolescent overweight (WHO, 2010). This paper examines a health programme called Health Profiles (HP) that targets Danish high school students aged 16-19. The programme aims to improve health and prevent obesity, particularly among those students who have the poorest health-related test results at the outset.

The HP programme involves students making their own measurements of a number of health-related parameters. The students are measured in physical education classes, and the measurements are supervised by the teachers. The idea underlying the HP programme is that when students are involved in making the measurements they will become more aware of their own state of health, and consequently will be motivated to improve it. Improvement of health behaviour could be discussed with the teacher. Individual health profiles are created for each student.

School-based interventions have the advantage that it is possible to engage the least physically active students. Many school-based projects have been conducted to tackle the obesity epidemic, but a recent meta-analysis showed that these have had limited effects on BMI (Harris et al., 2009). However, other health related benefits were found. In a Cochrane review, Dobbins et al. analysed 26 school-based interventions, and positive effects were observed for duration of physical activity, television viewing, aerobic fitness and blood cholesterol (Dobbins et al., 2009). The effects depend on the strength and the type of the exposure. Programmes that increased the number of physical education lessons slightly, e.g. from two to four lessons per week, have produced either no effect or

only small effects (Hasselstrom et al., 2008). However, more far-reaching interventions involving up to 60 minutes of physical activity daily have been found to create substantial health effects, with major increases in physical fitness and improvements in blood lipids (Kriemler et al., 2010; Resaland et al., 2009; Resaland et al., 2010). This type of intervention may, however, be difficult to implement in most schools, and cheaper strategies that are more realistic and easier to implement are needed. The current approach is very cheap and easy to implement, and it is therefore important to analyze if it improves health.

The aims of this paper were to examine if 1) Bmi has changed in high school population similarly to the general population, and 2) measure the effect of participating in the HP programme, which involves measuring and increasing students' knowledge of a number of health-related parameters.

Methods

The data were collected through the database on the common website. Thus, none of the measurements were made for research purposes. Study approval was sought from the Danish Bioethics Committees for the Capital Region of Denmark (DBCCRD). The DBCCRD stated that this study did not constitute a bioethics project and therefore could be started without approval from the DBCCRD. Information on gender and school year is available for each student, together with the dates the measurements were taken for the selected health parameters. The measurements were taken over the period 2004-2007 for the intervention group and in 2005 for the control group.

Participants

This study uses two data samples. The first comprises measurements for 2,498 first year students (1,050 boys and 1,448 girls) from fourteen high schools who participated in the HP programme. These data we used for comparing with data from students in earlier years and thus for calculating obesity trends over time among high-school students in Denmark. Data from third-year students in four high schools were analysed to assess the effect of the HP programme. There were 129 of these third-year students (53 boys and 76 girls) who had been only measured once, having joined the programme only in their final year, and 94 third-year students (39 boys and 55 girls) who had been measured three times, in each of their years of study at high school. Physical education teachers from all high schools in Denmark were informed about the programme, but only 14 schools decided to participate. Schools were recruited on a voluntary basis. There is around 100 high school totally in Denmark. When these participating schools chose to join the programme, all students in all classes were involved in the project. The measurements were voluntary but very few students declined to be measured.

The second data sample is a trend analysis based on representative data from high school students collected in 1983 (Andersen & Schelin 1994); and in 1994 (Nielsen & Andersen 2003) compared to the present programme. The study from 1983 included a random sample of 800 high school students and the data collected in 1994 included 13557 students.

Measurements and intervention

The students were measured on various health parameters. A more detailed description (in Danish) of the measurements and the methods used for the different tests can be found at www.sundhedsprofiler.dk.

The profile was made up of the results of a number of physiological measurements, including height, weight, peak flow, vital capacity, pulse at rest, blood pressure, body fat percentage and aerobic fitness. Each student could access his or her own profile via the programme website by means of a coded login system. The combined set of results constituted the student's health profile. Averages of the results for the participating schools, calculated by year group and by school, were accessible from the website, and students could see the averages for their own year group from their personal web page and compare the relevant average to their own measurements. The health profiles were used in school lessons to educate students, and teachers could discuss results and guide students in how they best could change their health behaviour. The intervention was therefore a combinaion of students own awareness and input from teachers based on the health profile.

Body mass index (BMI) was calculated as weight in kg divided by height in meters squared. Fat percentage was measured using a bioelectric impedance analyser (Omrun BF 302 and Omrun BF 306); and aerobic fitness was assessed using a “beep test” (Léger & Gadoury, 1989).

The HP programme included a questionnaire with ten questions relating to the students' psychosocial situation. The psychosocial questionnaire was prepared by teachers involved in the programme together with researchers from the University of Southern Denmark, and includes questions such as "How often do you feel tired?", "Are you happy with your own everyday life?" and "Are you satisfied with your body?", each with four response options (e.g. always, often, sometimes, never). The full questionnaire is available upon request. The fewer points scored, the better the student's psychosocial level.

Data analyses

Two strategies were used to investigate the HP programme. First, we examined the general trend in overweight among high school students from 1987 to 2005 to show whether any general improvements had taken place in the state of health of Danish high school students. Second, we evaluated the effect of the HP programme.

Measurements of BMI for first-year high-school students taken at the start of the programme (and thus of students who had not been treated when measured) were compared with historical data for first-year high-school students. A study of high-school students was conducted in 1983 using two samples, of students from 107 and 18 high schools respectively (Andersen, 1994; Andersen & Schelin, 1994). Another study of high-school students was conducted in 1994, in which 91 high schools participated (Nielsen & Andersen, 2003). All these surveys drew on schools from all over Denmark. As the high schools participating in the HP programme self-select into the programme, they represent a convenience sample. Consequently, we might expect the BMI distribution from 2005 – the year for which data from the HP programme were used for comparison – to represent a lower bound.

The effect of the HP programme was examined by comparing measurements for third year students who had participated in the programme in their first and second school years (the intervention group) with third year students who were already in their third year when the programme began in their schools, and thus had not previously participated in the programme (the control group). Quantile regression models (Koenker & Hallock, 2001) and standard ordinary least squares (OLS) models were used to explore the correlations between the students' participation in the health programme and their BMI, body fat percentage, aerobic fitness and wellbeing. To examine the effect of the HP programme on health among high-school students, results for girls and boys were pooled, and the analysis was adjusted for sex. A simple t-test of the mean height ($t=1.2$, $p=0.24$) and fraction of boys in the sample ($t=0.29$, $p=0.77$) showed no significant differences between intervention and control groups.

Results

General trends in health indicators for first-year high-school students, 1983 to 2005

Figures 1 and 2 indicate that BMI increased across the distribution among first year high-school students, and by a greater amount among boys and girls with a relatively high BMI. When data for height instead of BMI are plotted in Figures 1 and 2, it can be seen that there is an increase in the average height of students only in the lowest deciles (these figures are available upon request). The results shown in Figures 1 and 2 were not altered when Ponderal Index values ($kg*m^{-3}$) were plotted instead of BMI. This measure makes allowance for the increase in height that has taken place over time.

>INSERT FIGURES 1 and 2 HERE<

The impact of Health Profiles on BMI, body fat percentage and aerobic fitness

Table 1 shows that participation in the Health Profiles programme significantly increased the BMI for students with a BMI value ranging from the 25th percentile up to the 75th percentile. The BMI values also increased among students participating in the programme who had high BMI levels (85th and 95th percentiles), but the increase was not statistically significant.

The results in Table 1 have been estimated taking into account students' height (these results are not shown). If there was a significant difference in the state of health between students at experimental and control group schools, we would expect that height would account for a part of the correlation between BMI and participating in the HP programme. However, there is no indication that this is the case.

Table 1 shows that students' body fat percentages were significantly reduced among students in the 85th percentile. Across the remainder of the distribution, participating in the HP programme did not significantly change the body fat percentage.

Table 1 also shows the effects of the HP programme on students' aerobic fitness. There were significant improvements in the aerobic fitness of students between the 25th percentile and the 75th percentiles, while there were no significant changes among students with the lowest and highest aerobic fitness levels, which could be attributed to the fact that the number of observations is small for the very high and very low percentiles.

>INSERT TABLE 1 HERE<

Evaluations of students using a psychosocial measure

The students in the HP programme also answered 10 questions related to their psychosocial situation. The fewer points scored, the better the student's psychosocial measure. The results in Table 1 indicate that participating in the HP programme improved students' psychosocial state. However, this finding is only significant for the overall average (OLS).

In Table 2, the students are divided according to their state of health and then evaluated according to the average of their psychosocial state (OLS). The results indicate that participating in the HP programme significantly improved students' psychosocial condition in the case of students with a relatively high BMI, low body fat percentage and poor aerobic fitness. Changing the limits for the

low and high values for the health parameters did not produce any changes in the significant results shown in Table 2.

Discussion

This paper shows that there has been a general increase in BMI levels among Danish high school students since 1983, and that the increase is particularly marked among students with the highest levels of BMI. This accords with results from other countries, which have shown that the prevalence of overweight among children and adolescents has increased since the 1980s (Ogden et al., 2002; Wang & Lobstein 2006). While the increase in prevalence of overweight and obese adolescents is a major health problem, the increase in BMI of normal and low weight adolescents may be seen as an improvement of the health condition probably related to better nutritional status. Promoting the health of adolescents and preventing the risk of chronic conditions through school-based initiatives is an important goal in view of this increasing trend in obesity.

This paper examines the question of whether health initiatives such as the Health Profiles (HP) programme can have a positive effect on the health of high-school students. The results of the study suggest that BMI levels increased as a result of students' participation in the HP programme. This result is, however, statistically significant only for students with average BMI levels. As the BMI does not distinguish between muscle and fat tissue, this increase could be caused by an increase in muscle tissue. The body fat percentage and aerobic fitness were also measured for students who participated in the HP programme. The results of these measures indicate that students with high body fat percentages reduced their level of body fat through participation in the programme, while students with poor aerobic fitness improved their fitness through the programme. Both of these findings are important in order to improve metabolic health. The secular trend analysis show that BMI has increased more in the upper part of the distribution, and both the overweight and low fit children are difficult to reach in interventions targeted at the general population. It is therefore

important that it seems like a changed has happened among the adolescents who need it most, and who are less likely to be reached through sports organizations.

The students who participated in the HP programme also completed a questionnaires focused on their psychosocial states. The results of this survey suggested that participation in the HP programme improved students' psychosocial state, especially among students in a relatively poor state of health as measured by BMI and aerobic fitness.

Brown & Summerbell (2009) have recently reviewed school-based interventions aiming at preventing obesity. They updated an earlier review, where 23 studies were identified between 1990 and 2005. An additional 15 studies were identified between 2006 and 2007. One of three (33%) diet studies, five of 15 (33%) physical activity (PA) studies and nine of 20 (45%) combined diet and PA studies demonstrated significant differences in BMI for intervention and control groups. There was insufficient evidence to assess the effectiveness of dietary interventions to prevent obesity in school children or the relative effectiveness of diet vs. PA interventions. Effect sizes were rather small, and less than half of the studies showed significant effects of the intervention on BMI. However, physical activity and diet could have resulted in other positive health effects, and physical activity may increase muscle mass and decrease fat mass without any change in BMI. The present paper adds to the literature by evaluating the effect of a school-based health initiative not only on BMI but also on aerobic fitness and body fat percentage. The results indicate that among the students with the poorest results at the outset, participation in a HP programme, which involves measurements of and information on a number of health-related parameters, improved aerobic fitness and body fat percentage, while there was an increase in BMI (significant at 10 pct.).

It is important to point out that the overall effect of the Health Profiles programme must be viewed as the effect on motivated participants. The high schools involved had opted to enrol in the Health Profiles programme and there was a fee for the schools to participate. This probably resulted in both teachers and students being motivated to participate, and possibly to supplement elements in the programme with additional health-related activities. This means that we are not able to use these data to verify whether the positive effect of a health programme like HP would apply to all adolescents aged 16-19.

The study has several limitations. Recruitment to the intervention was based on a network of high school physical education teachers with an interest in internet based learning. There is therefore a high degree of selection of participating classes and schools. However, the control group had the same motivated teachers, but they were measured when they entered the program, which made it possible to compare with same age students who had been in the program for two years. Accuracy of measurements is another limitation. Measurements were done by teachers and not scientists and equipment was not standardized in a rigid way. This has caused some error variation, but it is unlikely it has caused bias. The same teachers measured students from the intervention and control group, and they did not know that some classes would be used as control groups. When they measured classes that were part of the control group, they believed that this was just another class entering the program. Assessment of fitness was indirect (20 m shuttle run) and also assessment of fat percentage by bioimpedance has limitations. Again, it is unlikely it creates bias, and error variation will drive results against the null hypothesis. A main limitation of the design is that it may be difficult to generalize results to other high schools with less motivated teachers.

Conclusion

Despite the small number of observations, the results show consistently that the Health Profiles programme had a positive impact on the student's health, and especially among students with a high percentage of body fat and poor aerobic fitness. Consequently, measuring high-school students' health with various measurements and providing them with information on their health status and ways to improve it appears to be a useful tool when used with committed participants in the battle against the increasing trends in adolescent overweight and obesity.

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Tables:

Table 1. The effect of participating in the Health Profiles programme (HP)[1] on various health measurements among Danish third-year high-school students. Parameter estimates from OLS and quantile regressions on BMI levels, body fat percentages, aerobic fitness and wellbeing. Adjusted for sex (boy). Standard errors in parentheses.

	25th percentile	50th percentile	OLS	75th percentile	85th percentile	95th percentile
BMI						
HP	0.928+	1.125*	1.002*	0.783*	0.519	2.450
	(0.473)	(0.492)	(0.422)	(0.388)	(1.032)	(2.245)
Boy	1.061*	0.973+	1.070*	0.917*	2.234*	1.060
	(0.475)	(0.494)	(0.423)	(0.388)	(1.028)	(2.261)
N	223	223	223	223	223	223
Body fat percentages						
HP	-0.900	1.200	-0.325	-0.300	-2.900*	-1.100
	(1.037)	(1.057)	(0.772)	(1.194)	(1.325)	(3.098)
Boy	-13.30***	-12.90***	-12.42***	-11.90***	-11.50***	-9.500**
	(1.054)	(1.070)	(0.782)	(1.208)	(1.346)	(3.094)
N	230	230	230	230	230	230
Aerobic fitness						
HP	3.900*	3.500***	3.710**	3.000*	1.700	3.900
	(1.561)	(0.970)	(1.271)	(1.251)	(2.340)	(11.28)
Boy	12.00***	11.30***	13.00***	11.60***	10.60***	12.90
	(1.553)	(0.960)	(1.258)	(1.244)	(2.296)	(11.08)
N	196	196	196	196	196	196
Psychosocial scores						
HP	-1.000	-1.000	-1.317*	-1.000	-1.000	-4.000
	(0.637)	(1.012)	(0.522)	(0.902)	(1.421)	(2.647)
Boy	3.40e-16	-1.000	-0.278	-1.000	-1.000	1.000
	(0.644)	(1.010)	(0.529)	(0.922)	(1.452)	(2.695)
N	232	232	232	232	232	232

Notes: [1] The intervention group, students who were measured in the programme every year for three years, has the value HP=1. These measurements were collected in 2004-2007. The intervention group is compared with the control group (HP=0) who were measured only in their third year. The measurements for the control group were collected in 2005.

+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 2. The effect of participating in the Health Profiles programme (HP) on psychosocial states among Danish third-year high-school students, 2004-2008. Parameter estimates from OLS regressions estimated on subsamples of students with relatively high and low BMI, body fat percentages and aerobic fitness. Adjusted for sex (boy). Standard errors in parentheses.

	Low BMI	High BMI	Low body fat percentage	High body fat percentage	Good fitness	Poor Fitness
HP	-1.291	-1.850**	-1.423+	-1.076	-1.397	-1.790*
	(0.834)	(0.705)	(0.793)	(0.736)	(0.850)	(0.858)
Boy	-1.641+	0.883	0.796	0.322	1.129	0.428
	(0.836)	(0.698)	(0.956)	-1.317	(0.951)	-1.290
Number of observations	99	124	104	124	96	100

Note: + p<.10, * p<.05, ** p<.01, *** p<.001

Figures:

Figure 1: Distribution of BMI among Danish first-year high-school boys in 1983, 1994 and 2005. Average BMI level is calculated separately for each decile, starting with the lowest, so that changes across the entire distribution are shown.

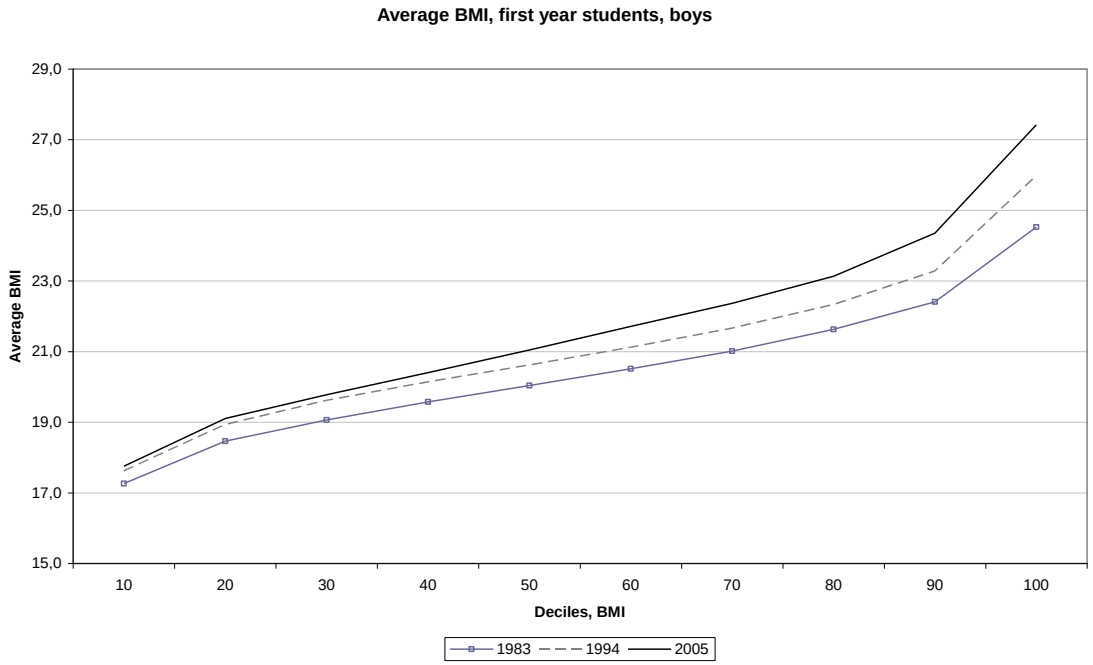

Figure 2: Distribution of BMI among Danish first-year high-school girls in 1983, 1994 and 2005. Average BMI level is calculated separately for each decile, starting with the lowest, so that changes across the entire distribution are shown.