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Physical activity, weight status and diet in adolescents: are children meeting the guidelines?

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ABSTRACT

Childhood obesity is on the increase and maintaining regular physical activity and consuming a healthy diet have become essential tools to combat the condition. The United Kingdom government has recommended guidelines for optimal levels of diet and activity in children. The aim of this paper is to describe and compare self-reported physical activity levels, diet, and Body Mass Indices (BMI) amongst adolescent children, aged 11-15, in the South West (SW) and North West (NW) regions of England and to see if these children were meeting the current targets for optimal levels of: physical activity; fruit/vegetable consumption; fat consumption and BMI. We report the results of a cross-sectional survey of four secondary schools and 1,869 children using the self-reported Western Australian Child and Adolescent Physical Activity and Nutrition Survey (CAPANS) physical activity instrument and a food intake screener questionnaire, in summer and winter. We found that 25% (469/1869) 95% CI: 23% to 27%, of children engaged in 60 minutes of moderate to vigorous physical activity per day; 53% (995/1866) 95% CI: 51% to 56%, took 5 portions of fruit and vegetables per day; while 22% (407/1861) 95% CI: 20% to 24% consumed recommended amount of fats, and 23.7% (276/1164) 95% CI: 21% to 26%, of pupils were obese or overweight as classified by their BMI. Self reported physical activity in young people regardless of area is lower than previously reported and the lack of students engaging in 60 minutes moderate to vigorous activity could have serious public health consequences. If sustained, this could lead to more overweight adults, and more ill health.

Keywords: Physical Activity; Diet; Exercise;

Adolescents; Guidelines

1. INTRODUCTION

There is considerable evidence that adult health varies according to the region in England in which they live [1-5]. Life expectancy throughout England differs markedly between regions [6]. The health consequences of being overweight or obese in adulthood are now well established [7]. A systematic review of the short and long-term consequences of childhood obesity reported short term clinical effects of obesity on children such as increased incidence of asthma and diabetes but also long term consequences of increased risk of cardiovascular disease into adulthood [8]. Childhood obesity is now becoming more prevalent: the latest figures for England, in 2006, show 23.7% of 11-15 year old males and 26.2% females are now classed as obese [9]. Taking regular exercise and maintaining a healthy weight through diet are thought to be essential factors in combating this trend [10].

The United Kingdom (UK) government has recognised the public health consequences for the rising trend in obesity in the population and has set targets for healthy Body Mass Index (BMI), physical activity and diet in children [11]. The current guidelines recommend 60 minutes of moderate to vigorous activity per day [11]. However, the number of secondary school children achieving this level of activity varies from 41% (ages 11 to 15) [12] to 80% (age 11) [13]. Dietary guidelines also recommend the consumption of at least five portions of a variety of fruit and vegetables per day and that less than 35% of daily dietary calorific intake should be made up of fats [14]. Fat intake in a national diet survey [15], in young people age 4-18 years, was 36.9%, around the recommend level but fruit and vegetable consumption was mixed. However, another later health survey [13] showed that only 13% of children aged 5-15 years had eaten the recommended five or more portions of fruit and vegetables in the previous day.

This cross sectional self report survey aimed to describe and compare self-reported physical activity levels, diet, weight and height amongst adolescent children, aged 11-15, in the South West (SW) and North West (NW) regions of England and to see if these children were meeting the current targets for optimal levels of: physical activity; fruit/vegetable consumption; fat consumption and BMI.

2. METHODS

2.1. Design and Setting

Four comprehensive secondary schools were matched according to characteristics described in Office for Standards in Education (Ofsted) reports; two were in the northwest of England, two in the southwest. The schools were selected on the basis of a close match in: examination results, percentage of children on free school meals (FSM), and percentage of children with special educational needs (SEN). Questionnaires were completed in class in the presence of a teacher and the same questionnaires were completed twice, once in the summer term and once in the winter term.

University of Sheffield research ethics committee approval was obtained for this study and the Local Education Authority was consulted in order to gain initial contact with the secondary schools involved. Consultation with the heads of the secondary schools followed this. Initially the study details were circulated in a school new-

spaper, which every parent receives, at each school. After this process the whole school populations were given an information letter to take home with a consent slip to be returned by a parent or guardian. As children were of secondary school age it was thought they could sign consent to fill out a survey on the day of the study, if a parental slip had not been returned [16].

2.2. Participants

Two thousand eight hundred and fifty-eight pupils aged 11-15 in four secondary schools in England (2 in the NW) and 2 in the SW) region) were sent a letter with consent slip attached explaining the survey study and invited to participate in an anonymous survey on two occasions (summer and winter). Thirty percent (869/2858) of children responded to the winter survey and had valid self-reported physical activity data, and 35% (1000/2858) responded to the summer survey, an overall response rate of 33% (1869/5716) (see **Table 1**). As this was an anonymous survey no information was collected on the characteristics of the non-respondents to the questionnaire, therefore a comparison of respondents to non-respondents cannot be made. We also have no information on how many children completed the survey in both winter and summer.

2.3. Measures

Self-reported demographic information was collected from the pupils such as age, sex, ethnicity, entitlement to free school meals, height and weight.

Table 1. Survey response rates and school characteristics.

	School				Totals
	1	2	3	4	
Number of children role	1198	923	922	671	3714
GSCE Examination Results (2004)					National Average = 54.5%
% five or more passes with grades A to C	43%	52%	42%	51%	
Key stage 3 assessment results (2004)					England Average Point Score = 34.1
(average point score)	32.8	32.5	31.9	33.9	
Percentage of SEN pupils on statement (2005)	1.8%	2.1%	7.1%	3.4%	National Average SEN with Statement = 2.9%
Percentage, with SEN but not on statement	25.1%	27.1%	5.9%	16.7%	without statement = 14.9%
1st wave: winter 2006					
No. of children sent letters	965	744	567	582	2858
Questionnaires returned	438	343	213	64	1058
Incomplete questionnaires	81	83	25	0	189
Responders	357	260	188	64	869
1st wave overall response rate	357/965 (37%)	260/744 (35%)	188/567 (33%)	64/582 (11%)	869/2858 (30%)
2nd wave: summer 2007					
No. of children sent letters	965	744	567	582	2858
Questionnaires returned	543	261	225	279	1308
Incomplete questionnaires	118	84	53	53	308
Responders	425	177	172	226	1000
2nd wave overall response rate	425/965 (44%)	177/744 (24%)	172/567 (30%)	226/582 (39%)	1000/2858 (35%)

SEN (Special Educational Need); GCSE (General Certificate of Secondary Education Examination)

2.4. Physical Activity

The self-completed Western Australian Child and Adolescent Physical Activity and Nutrition Survey (CAPANS) questionnaire was used to assess physical activity [17]. The CAPANS consists of 24 questions and was first successfully used in a sample of 2274 children aged 7 to 16 years in 2003 [18]. The CAPANS asks children to select the type of physical activity (from a comprehensive list of activities) they usually do in a typical week; and then to record the number of times they did the activity and the time spent on that activity. The total time spent on physical activity per week was calculated by totalling the time children spent in moderate or vigorous activity per day and then dividing this figure by seven to give an average for the week. The UK government recommends children are physically active at a moderate intensity for 60 minutes per day [11]. Therefore the physical activity data was further classified into whether or not children were meeting these recommendations or not.

2.5. Diet

The Block food intake screener was used to assess diet and the intake of fat, fibre, fruit and vegetables [19]. The responses to the screener can then be used to estimate the amount of fat and fruit and vegetables a child is consuming in their diet. Fat and fruit intake for each child was then further classified as achieving the optimal consumption of fats (< 35% of calories consumed per day) or fruit and vegetable (at least 5 portions per day) or not.

2.6. Body Mass Index (BMI)

The pupils estimated their own height and weight which was then used to calculate each child's BMI. UK specific BMI reference values and cut-points were then used to classify each child as having normal weight or being overweight or obese [20].

2.7. Statistical Analysis

Continuous outcomes such as minutes of vigorous activity per day were compared between areas using a two independent samples *t*-test. Binary outcomes e.g. achieving 60 minutes of physical activity per day, yes or no, were compared between areas using a chi-squared test. Multiple linear regression (for continuous outcomes) and multiple logistic regression (for binary outcomes) was used to adjust the area effect for the potential confounding variables of ethnicity (white vs. none-white), sex (boy or girl) and age (years) which were known to be associated with physical activity [12,21,22]. Also adjusted for was receipt of free school meals (yes or no) as a proxy measure for deprivation. The multiple regression

analyses also adjusted for potential clustering of pupils' outcomes within the schools by calculating robust standard errors with the cluster option in STATA v11 [23]. This was an anonymous survey and we have no information about whether or not the children completed the survey twice in both winter and summer. Therefore the majority of the statistical analyses were performed and reported separately by season. A P-value of less than 0.05 was regarded as statistically significant.

3. RESULTS

Table 1 shows the overall response rate to the survey was 33% (1869/5716). The demographic characteristics of the respondents, in both summer and winter samples, can be seen in **Table 2**. There was some evidence of statistically significant differences in the social demographic characteristics of the pupils between the two areas.

Table 3 shows that the proportions of children achieving the UK recommended guidelines of 60 minutes moderate to vigorous physical activity per day, was higher in summer compared to winter, 32.2% (322/1000) vs. 16.9% (147/869). There was no evidence of a difference in proportions achieving the recommendations between areas in summer or winter (with and without adjustment for covariates, such as sex, age, ethnicity and receipt of free school meals). Overall only 25% (469/1869), 95% CI: 23% to 27%, of children met the target of 60 minutes moderate to vigorous physical activity per day. Similar findings were observed for the continuous outcome of minutes of moderate to vigorous physical activity per day. Children were observed (see **Table 4**) to be undertaking more physical activity in summer than in winter, but there was no statistical evidence of a difference between areas in summer or winter (with and without adjustment for covariates). Children in the SW were observed to be undertaking less sedentary behaviour per day than children in the NW, both in summer and winter (**Table 4**), although only in summer was this difference statistically significant ($P = 0.003$) and this difference was not statistically significant after adjustment for covariates.

Optimal fruit and vegetable consumption, of five or more portions per day, was higher in summer than winter, 57% (566/1000) vs. 50% (429/866), see **Table 3**. There was no evidence of a difference in consumption between areas in winter (with and without adjustment for covariates). However there was some evidence of a difference between areas in the summer, with the odds of children in the SW having optimal fruit consumption being 1.8 (95% CI: 1.38 to 2.32, $P < 0.001$) times that of the odds of children in NW, but this difference was not statistically significant after adjustment for covariates.

Table 2. Demographic characteristics of sample by area and season.

		Total		Area				Absolute difference (SW-NW)	Odds Ratio SW/NW	95% CI	P-value ¹
		n	%	Northwest		Southwest					
				n	%	n	%				
Winter											
Sex	Male	439	50.5%	333	54.0%	106	42.1%	-11.9%	0.62	(0.46 to 0.83)	< 0.001
	Female	430	49.5%	284	46.0%	146	57.9%				
	Total	869	100.0%	617	100.0%	252	100.0%				
Ethnicity	Non-white	338	38.9%	322	52.2%	16	6.3%	-45.9%	0.06	(0.04 to 0.11)	< 0.001
	White	531	61.1%	295	47.8%	236	93.7%				
	Total	869	100.0%	617	100.0%	252	100.0%				
Child in receipt of free school meals	No	701	80.9%	485	78.6%	216	86.4%	7.8%	1.73	(1.15 to 2.63)	0.008
	Yes	166	19.1%	132	21.4%	34	13.6%				
	Total	867	100.0%	617	100.0%	250	100.0%				
Summer											
Sex	Male	528	52.8%	373	62.0%	155	38.9%	-23.1%	0.39	(0.30 to 0.51)	< 0.001
	Female	472	47.2%	229	38.0%	243	61.1%				
	Total	1000	100.0%	602	100.0%	398	100.0%				
Ethnicity	Non-white	383	38.3%	361	60.0%	22	5.5%	-54.5%	0.04	(0.02 to 0.10)	< 0.001
	White	617	61.7%	241	40.0%	376	94.5%				
	Total	1000	100.0%	602	100.0%	398	100.0%				
Child in receipt of free school meals	No	826	82.7%	473	78.6%	353	88.9%	10.3%	2.19	(1.49 to 3.16)	< 0.001
	Yes	173	17.3%	129	21.4%	44	11.1%				
	Total	999	100.0%	602	100.0%	397	100.0%				
		n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	Difference	95% CI		P-value ²
Winter											
Age (years)		869	13.0 (1.2)	617	13.1 (1.2)	252	13.0 (1.3)	-0.1	(-0.2 to 0.1)		0.478
Summer											
Age (years)		1000	13.2 (1.3)	602	13.1 (1.3)	398	13.5 (1.3)	0.4	(0.2 to 0.5)		< 0.001

1. P-value from chi-squared test; 2. P-value from two independent samples t-test.

Optimal fat intake in diet, of consumption of < 35% of daily calories with fat, was marginally lower in summer than winter, 21.4% (214/1000) vs. 22.3% (193/864), see **Table 3**; but there was no evidence of a difference in consumption between areas in summer or winter (with and without adjustment for covariates).

The proportion of children with a normal BMI was higher in summer than winter, 78.9% (345/437) vs. 74.7% (543/727), see **Table 3**. There was no evidence of a difference in the proportions with a normal BMI between areas in summer or winter before adjustment for covariates. However, after adjustment there was some evidence of a significant difference between areas, in both the summer and winter, with children in the SW being less likely to have a normal BMI (*i.e.*, more likely to be overweight) than children in the NW. Using the continuous BMI measurement (see **Table 3**) children in the SW were observed to have a larger BMI than children in

the NW in both summer and winter surveys. However this difference was only statistically significant in the winter survey after adjustment for covariates. The converse was true for the summer survey as the difference between areas was only statistically significant before adjustments for covariates and not after. Overall, 24% (276/1164), 95% CI: 21% to 26%, of pupils were classified as overweight or obese.

4. DISCUSSION

The present findings of this study indicate that only 25% (17% in winter, 32% in summer) of children aged 11-15 years were engaging in 60 minutes of moderate to vigorous physical activity per day; 53% took five or more portions of fruit and vegetables per day; 22% consumed the recommended amount of fats, and 24% of pupils were obese or overweight as classified by their BMI [24].

Table 3. Binary physical activity, fruit intake, fat intake and BMI outcomes by area and season.

Outcome	Overall Totals			Northwest (NW)		Area Southwest (SW)		Absolute difference (SW-NW)	Odds			Adjusted ² Odds		
	n	%	(95% CI)	n	%	n	%		Ratio _{SW/NW}	95% CI	P-value ¹	Ratio _{SW/NW}	95% CI	P-value ²
Winter														
Achieving 60 mins of Physical Activity per day	147/869	16.9%	(14.6 to 19.6%)	106/617	17.2%	41/252	16.3%	-0.9%	0.94	(0.63 to 1.39)	0.745	1.31	(0.38 to 4.57)	0.669
Optimal fruit/vegetable intake	429/866	49.5%	(46.2 to 52.9%)	304/614	49.5%	125/252	49.6%	0.1%	1.00	(0.75 to 1.35)	0.980	0.99	(0.52 to 1.87)	0.968
Optimal fat intake	193/864	22.3%	(19.7 to 25.2%)	138/612	22.5%	55/252	21.8%	-0.7%	0.96	(0.67 to 1.37)	0.816	1.18	(0.62 to 2.22)	0.612
Normal BMI	543/727	74.7%	(71.4 to 77.7%)	390/523	74.6%	153/204	75.0%	0.4%	1.02	(0.71 to 1.49)	0.905	0.86	(0.78 to 0.94)	0.001
Summer														
Achieving 60 mins of Physical Activity per day	322/1000	32.2%	(29.4 to 35.2%)	203/602	33.7%	119/398	29.9%	-3.8%	0.84	(0.64 to 1.10)	0.206	1.35	(0.71 to 2.59)	0.359
Optimal fruit/vegetable intake	566/1000	56.6%	(53.5 to 59.6%)	307/602	51.0%	259/398	65.1%	14.1%	1.79	(1.38 to 2.32)	<0.001	1.86	(0.89 to 3.89)	0.098
Optimal fat intake	214/1000	21.4%	(19.0 to 24.0%)	126/602	20.9%	88/398	22.1%	1.2%	1.07	(0.79 to 1.46)	0.656	1.56	(0.96 to 2.53)	0.072
Normal BMI	345/437	78.9%	(74.9 to 82.5%)	218/273	79.9%	127/164	77.4%	-2.5%	0.87	(0.54 to 1.39)	0.549	0.48	(0.30 to 0.76)	0.002

Optimal fruit/vegetable intake is defined as the consumption of 5 or more portions per day. Optimal fat intake is defined as the consumption of < 35% of daily calories with fat. 1. P-value from chi-squared test; 2. Adjusted for age, sex, ethnicity (white/non-white), receipt of free school meals (yes/no) and clustering by school.

Table 4. Continuous physical activity and BMI outcomes by area and season.

Outcome	Overall Totals			Northwest			Area Southwest			Unadjusted Mean			Adjusted ² Mean		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	difference	95% CI	P-value ¹	Difference	95% CI	P-value ²
Winter															
Minutes of moderate/vigorous physical activity per day	868	36.4	35.7	617	36.5	38.9	251	36.0	26.2	-0.5	(-5.7 to 4.8)	0.857	4.6	(-20.6 to 29.7)	0.604
Minutes of sedentary behaviour per day	869	304.3	172.9	617	308.7	183.7	252	293.6	142.8	-15.1	(-40.5 to 10.2)	0.242	-20.8	(-78.6 to 37.0)	0.335
BMI (kg/m ²)	728	19.1	3.8	524	19.0	4.0	204	19.2	3.3	0.2	(-0.4 to 0.8)	0.568	0.5	(0.2 to 0.8)	0.012
Summer															
Minutes of moderate/vigorous physical activity per day	1000	50.5	38.9	602	52.0	39.9	398	48.2	37.2	-3.8	(-8.7 to 1.2)	0.134	6.2	(-5.6 to 18.1)	0.192
Minutes of sedentary behaviour per day	999	239.9	121.9	602	249.2	124.6	397	225.7	116.6	-23.5	(-38.9 to -8.1)	0.003	-32.9	(-86.2 to 20.5)	0.145
BMI (kg/m ²)	437	18.8	3.66	273	18.5	3.7	164	19.4	3.6	0.9	(0.2 to 1.6)	0.013	1.0	(-0.4 to 2.3)	0.105

1. P-value from two independent samples t-test. 2. Adjusted for age, sex, ethnicity (white/non-white), receipt of free school meals (yes/no) and clustering by school.

The physical activity results from the present study are lower than two previous studies. An international World Health Organisation [25] study reported that 45% of 11 year olds and 38% of 15 year olds were achieving the recommend levels of physical activity. More recently a British Heart Foundation [12] survey reported that 41% of 11-15 year olds were meeting the physical activity target. Our current data also revealed that the mean time spent in moderate to vigorous activity by these children was 44 minutes per day which looks very low when compared to the mean amount of time spent in sedentary behaviour (270 minutes per day). These sedentary figures are particularly worrying as physical inactivity was thought to contribute to almost two million worldwide deaths [26]. If there is a tendency in self-report surveys to over-estimate physical activity then the figures reported in this study could well be an over estimate of the true activity levels [27]. In these circumstances this could be a worrying indicator for activity levels.

Since the early 1990's [14] the UK Government has encouraged the consumption of at least five portions of fruit and vegetables per day and a total fat intake of less than < 35% of calories consumed. The intake of fruit and vegetables has been particularly promoted amongst young children with free fruit schemes in UK schools [28]. Consumption of at least 5 portions in the present study was around 53% (50% in winter, 57% in summer) this was much higher than the 13% of children consuming the recommended in the national health survey [15]. Intake of fats in the data also uncovered that only around one in four (22%) of the children were taking in the recommended amount of fats in their diets, *i.e.*, less than 35% of calories consumed, indicating an over eating of fatty foods.

On an epidemiological basis for young people to be considered overweight they would need to have a BMI greater than or equal to the 85th percentile or to be obese it would need to be greater than or equal to the 95th percentile according to UK reference curves [20]. The mean age of the participants in this study was 13.2 years, therefore this would equate to a BMI score of overweight for boys 20.65 kg/m² and girls 21.74 kg/m² [20]. The children in this study were found to have a mean self-reported BMI of 19.7 kg/m², and 76% (888/1164) had a 'normal' BMI. If children were underreporting their weight, and/or over reporting their height, then this would result in a lower BMI. However, this study's estimate of 24% (25% in winter and 21% in summer) of children being overweight or obese compares favourably with other recent surveys [9].

The study has several strengths and limitations. We

had a large sample of over 1,800 children self-reporting diet and physical activity. We believe that the participants in this study represented an ethnically diverse cross section of the secondary school population that is broadly similar to many comprehensive secondary schools in England. The data was collected over the same period of time in all schools which should account for any differences in activity due to holiday periods or seasonality.

The generalisability of this study, to other schools and areas in England, is likely to have been affected by the low response rate of 33% (1869/5716). This study involved only four schools in two regions, and is not a random sample of pupils or schools, so therefore the results must be interpreted cautiously and cannot be wholly representative of other schools in the NW and SW or indeed England. The low response rate may have potentially caused a bias in the estimated differences in outcomes between the various groups. Unfortunately as this was an anonymous survey no information was collected on the characteristics of the non-respondents to the questionnaire, therefore a comparison of respondents to non-respondents cannot be made. Also since this was an anonymous survey we have no information on how many children completed the survey twice both in the winter and summer. So we cannot rule out that some bias may have been introduced into the sample. However, 23.5% of our survey participants were classified as obese which is similar to previous estimates for English school children aged 11-15 of 21%; although only 25% of our sample met the physical activity guidelines compared to around 52% reported nationally [25]. Our sample appeared to have similar levels for receipt of free school meals (18% vs. 16.5%) compared to school roll information.

We believe that the responders, to our survey, are more likely to be a well motivated group of students, who are more likely to report higher levels of physical activity and better levels of diet and lower levels of BMI (due to overestimating their height and underestimating their weight). If this is so then our estimates are potentially likely to be larger than the true values as we have a self-selected sample of students who eat and exercise well.

The cross-sectional design is less robust than a longitudinal study. So it must be clearly acknowledged that the data represents merely a snap shot of information on physical activity and diet. The diet questionnaire although validated and piloted by the authors has mainly been used in an adult non-UK population, which again may have an effect.

Pragmatically, we used self report methods rather than objective measures such as pedometers or accelerometers to estimate physical activity. This may have resulted

in an overestimate of activity particularly if this was a well motivated group of students. However, the use of objective measures, such as pedometers, is not without problems as the use of these tools tends to alter the behaviour of people being observed and again may result in an over estimate of activity. In general, the potential 'bias' of self-reporting survey methods for diet or PA is of concern to any researcher and the over-reporting in activity or under-reporting fat intake maybe a particular worry in studies of children [29]. However, in previous studies of children and PA the self-report survey shows some promise of being a quality research instrument with a young population [27] and remains the most widely used measurement tool [30].

For practical reasons (since we had a large sample) we used the self-reported CAPANS instrument to assess PA, which has been shown to be reliable and valid measure in children [17]. In several studies self-reported BMI in children has shown that students tend to underestimate their BMI. Those students who are overweight or obese tend to underestimate their BMI to a greater extent than normal weight students. However, further studies have found that differences between self-reported and measured height and weight in young people were not statistically significant and there was reasonable agreement between actual and self-reported measurements [31,32]. In other studies, which found differences, they reported that over 90% of adolescent participants estimated weight and height was in the correct BMI (Overweight/obese or Normal) classification group [33].

5. CONCLUSIONS

The findings of this study indicate that only 25% of children aged 11-15 years in the four English schools were engaging in the recommended 60 minutes of moderate to vigorous physical activity per day. This estimate is considerably lower than several previous reports which suggested that between 38% and 80% of children were achieving the recommended physical activity guidelines. This level of inactivity, observed in our survey, if sustained, could have serious future public health consequences for England. This may lead to an increased likelihood of being overweight in adulthood and consequently more ill health, with increases in the incidence of diabetes and coronary heart disease in adult life. Although the proportion of children with a normal BMI of 24% is similar to other UK studies the consumption of too little fruit and too much fat indicates few of these children at secondary school age are meeting the UK government targets of 5 or more portions of fruit and vegetables per day and less than 35% of daily calorie

intake made up of fat. More research is needed possibly linking self report and that of an objective nature, to measure activity and BMI, to confirm these findings.

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