Influence of body image in urbanized areas: Differences in long-term changes in teenage body mass index between boys and girls in Japan

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ABSTRACT

Japanese prefecture level panel data for the period 1986–2003 was used to analyze and compare the determinants of teenage body mass index (BMI) by sex. Major findings through random effects estimation were as follows: (1) BMI consistently increased during the period in males aged 10–16 and in females aged 10–13 years, but not in 16-year-old females; (2) BMI was not influenced by the degree of population density in males and younger females. However, the BMI of 16-year-old females was markedly lower in more densely populated residential areas. These findings suggest that girls who reach adolescence are more likely to diet and that this tendency is more distinct in more urbanized areas.

JEL classification: I10; I30; R11

Keywords: BMI; Diet.

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1. Introduction

It has recently been widely acknowledged that obesity is one of the major issues in the field of economics (e.g., Costa-Font and Gil, 2004; Cutler et al., 2003; Knai et al., 2007; Loureiro and Nayga, 2005). According to the Organisation for Economic Co-operation and Development (OECD, 2009), the rates of obesity in 2006 for Western developed countries such as the United States, United Kingdom, Australia and New Zealand were higher than 10%, whereas that of Japan was only 3.9%.[1] This suggests that, in comparison with Western countries, the problem of obesity is not as serious in Japan. However, rates of obesity in Japan were 2% in 1980 and 2.3% in 1990, approximately half of that in 2006. The proportion of the population that was obese was stable between 1980 and 1990, and it then increased between 1990 and 2006. A change in the lifestyle of Japan as a consequence of economic growth might partly explain the increasing rate of obesity.

A major change in the socioeconomic situation occurred in Eastern European countries, with transition to a free market economy, and this particularly influenced adolescent perceptions and lifestyles through the mass media (Vigenerova, 2007). The information inflow from Western developed countries had a major effect on adolescent behavior. Consequently, body weight and body mass index (BMI) were affected (Chrzanowska et al., 2007). The economic situation changed similarly in Japan, leading the lifestyle to be deeply influenced by that of Western developed countries. It has been reported that the lifestyle change in Japanese society influenced the degree of obesity of elementary school students in Japan (Kobayashi and Kobayashi, 2006). Socioeconomic factors may have a different effect on BMI in teenagers, according to age, sex and geographical area.

There appear to be economic factors contributing to differences in BMI by age and sex. Hamermesh and Biddle (1994) reported a beauty premium in the labor

[1] Rate of obesity is defined in this paper as percentage of the total population with body mass index over 30 kg/m^2.

market.[2] Beauty might be reflected in part in body form and BMI, such that obesity is negatively associated with beauty. Among females, body weight is negatively correlated with salary (e.g., Averett and Korenmans 1996, Cawley, 2004). Employment opportunities vary according to location. Edlund (2005) argued that a higher proportion of females tend to live in urban areas because these areas offer better labor markets as well as a better marriage market. Competitive pressure in labor and marriage markets is thought to become higher in urban areas than in other areas. As a consequence, females in urban areas are more likely to invest in body image. In other words, greater competitive pressures lead females to make a greater effort to diet in urban areas than in other areas. After completing school, girls naturally enter into such labor and marriage markets. In Japan, although compulsory education is completed at the junior high school level, 97% of teenagers continue into high school.[3] Competitive pressures are more likely to have an effect on teenage girls as they grow and approach high school graduation, usually about 17 years of age. In this paper, using Japanese prefecture panel data covering the period of the increase in teenage BMI (1986–2003), I investigate whether trends in teenage BMI differ across age groups and sexes, and discuss the results in relation to the influence of competitive pressures and body image.

2. Data and methods

3.1. Data

The source of the data of real per capita income and population density was from the Ministry of Internal Affairs and Communications (MIAC, 1987–2004). Height and weight was obtained from MECST (1987–2004)[3]. Indices of sports activity for boys and girls were collected from MIAC (1997) and calorie intake and animal fat intake were obtained from MHLW (1987–2004). The structure of the data set used in this study was panel. Micro data allow examination of individual behavior in detail, but micro data of the variables investigated here were not published and, therefore, were unavailable. In this paper, the data were aggregated at the prefecture level,

[2] Hamermesh and Biddle (1994) suggested three aspects of the beauty premium; employment discrimination and customer discrimination.

[3] Ministry of Education, Culture, Sports, Science and Technology Japan. http://www.mext.go.jp/a_menu/shotou/kaikaku/main8_a2.htm. (accessed at June 11, 2010).

comprising 47 prefectures, for the years 1986–2003[4]. A Japanese prefecture is a unit of regional government roughly equivalent to a state in the United States or a province in Canada. From the available data, BMI was calculated from height and weight and then used in the analysis. Among the variables, the indices of sports activity for boys and girls were only available for 1996 and 2001. I used the 1996 value and so this was only a proxy for sports activity. The estimation results using sports activity data for 1996 were similar to those using the data for 2001.

3.2. Econometric Framework

The definition and basic statistics of the independent variables are exhibited in Table 1. I used *INCOM* as an independent variable to control for the level of income. *DENS*, as a measure of population density, captured the differences in degree of urbanization among areas. *BSPORT* and *GSPORT* were included to control for behavioral factors such as sports activity. *BSPORT* was the active sporting population of males divided by the male population (all over 10 years old)[5]. *GSPORT* was the active sporting population of females divided by the female population (all over 10 years old). To capture eating habits, *CALO* (calorie intake) and *AFAT* (animal fat intake) were included as independent variables. *CALO* and *AFAT* were expressed as the averages of the observations from the various age groups in MHLW (1987–2004). Data for *BSPORT*, *GSPORT*, *CALO* and *AFAT* were not available for the individual age groups, while weight and height were available for each age group for both males and females. *BSPORT*, *GSPORT*, *CALO* and *AFAT* were included as factors reflecting the lifestyles of teenagers.

The estimated function is of the following form:

$$BMI_{ait} = \alpha_0 + \alpha_1\, INCOM_{it} + \alpha_2\, DENS_{it} + \alpha_3\, BSPORT\ (or\ GSPORT)_{it} + \alpha_4\, CALO_{it} + \alpha_5\, AFAT_{it} + e_t + v_i + u_{it},$$

here BMI_{ait} represents the dependent variable in age group *a*, prefecture *i* and year *t*; α represents the regression parameters; e_t captures the change in BMI during the period 1986–2003; v_i represents the unobservable individual effects of *i*'s prefecture (a fixed effects prefecture vector). v_i encompasses the time invariant feature, while u is an error term. With the exception of dummy variables, dependent and independent variables were evaluated with the sample means, and therefore the

4 Data set includes per capita income, population density, indices of sports activity, calorie intake, and animal fat intake.

5 The active sporting population was defined as those who participated in sport at least once a year.

coefficient values reported could be interpreted as elasticity.[6]

Special attention must be paid to the omitted variable bias stemming from the unobservable time-invariant prefecture's effects. With the aim of controlling for this bias, the random effects model was employed to capture v_i. It is known that the fixed effects model provides unbiased estimates (Baltagi, 2005). *DENS* is the key variable in this model, and its value is required to examine whether teenagers in more densely populated urban areas have a different BMI from teenagers in less densely populated areas. If teenagers are less likely to be fat, the expected sign of *DENS* becomes negative. A person who does physical work or participates in sports would burn more calories than less active individuals. *BSPORT* and *GSPORT* are thus reasonably expected to decrease *BMI* and produce a negative sign.

BSPORT and *GSPORT* are, however, time-invariant effects. Hence, results of *BSPORT* and *GSPORT* are not shown because they are completely controlled for when the fixed effects model is employed. On the other hand, the results of *BSPORT* and *GSPORT* can be available under the random effects model. The Hausman test asks if the fixed effects and the random effects estimates are significantly different. The random effects estimate is considered as valid when there is no difference. Accordingly, in the following section, the results of the Hausman test should be checked to validate the random effects model.

3. Overview of the change in teenage BMI.

Fig. 1 compares *per capita* income between urban and other areas.[7] It can be seen that the *per capita* income increased from 1985 to 1991 and did not markedly change after 1992. In addition, the level of *per capita* income in the urban areas was

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6 See more details for Greene (Greene1997, p.280).
In the linear model, $y = x'\beta + e$ the elasticity of y with respect to changes in x is

$$\gamma_k = \frac{\partial \ln y}{\partial \ln x_k} = \beta_k \left(\frac{x_k}{y} \right).$$

These values can be estimated at the sample means as

$$\lambda_k = \beta_k \left(\frac{\overline{x_k}}{\overline{y}} \right).$$

The standard error of the elasticity of y, γ_k, can be calculated by the delta method (Greene 1997, pp. 278–280).

7 In this paper, the top 4 most densely populated prefectures in 1988 (Tokyo, Kanagawa, Aichi, and Osaka) are defined as the urban areas. The rest of the prefectures are defined as the other areas.

consistently markedly higher than the other areas.

Figs. 2 and 3 demonstrate the changes in BMI by age group in males and females, respectively. In these Figures, panel (1), (2) and (3) represent 10-year-old, 13-year-old and 16-year-old groups, respectively. An increase in male BMI over the period was generally observed, with the exception of 16-year-olds in the urban areas. There was no marked difference in male BMI between urban and other areas in any age group. In general, an increase in female BMI was observed in most age groups, apart from 16-year-old females in urban areas. In addition, there was a marked difference in the BMI of 16-year-old females between urban and other areas, which was not observed in the other age groups. Joint consideration of Figures 1, 2, and 3 suggests that the increase in teenage BMI could be partly explained by the increase in *per capita* income before 1991, leading to changes in other factors which are thought to influence BMI e.g., lifestyle changes such as the use of air conditioning during the summer holidays encouraging children to stay indoors (Kobayashi and Kobayashi, 2006) and excessive calorie intake encouraged by the increased use of fast food in daily life. Nevertheless, the BMI of 16-year-old females did not increase, even under the socioeconomic changes.

4. Estimation results and their interpretation

Tables 2 and 3 show the results of the random effects estimations. *CALO* and *AFAT* were not available for 122 observations and so sample size used for estimation became smaller when these variables were incorporated. In all estimations, the random effects model is valid because there is no systematic difference between the results of the fixed effects estimation and the random effects model according to the Hausman test.

I will begin by discussing the results of Table 2. Concerning year dummies, in columns (1)–(5), most of the coefficients' signs are positive and statistically significant. In addition, the value of the coefficients and z-statistics increased monotonically as the years passed. On the other hand, in column (6), the signs of the coefficients are not stable and coefficients are not statistically significant. These results imply that BMI has increased over time in most age groups in males as well as in females, with the exception of the 16-year-old females. Similar results were obtained in the results incorporating *CALO* and *AFAT*, although they are not reported in Table 3. This indicates that girls entering adolescence maintain the same level of BMI during the studied period although other teenage groups increased BMI, which is consistent with the finding in Germany (Zellner et al., 2004).

INCOM shows positive signs in all estimations and is statistically significant for 13- and 16-year-old males and 13-year-old females. Furthermore, the value of the coefficient in column (3) is larger than that in column (2). These indicate that the positive effects of income level on BMI increased as male teenagers became older, whereas the positive effect disappeared when females became older. The BMI reflects not only the magnitude of obesity, but also the degree of muscularity. I interpret this result as suggesting that the higher the income level and the older the teenage boy, investment in physical exercise increased leading to an increase in BMI. On the other hand, teenage girls are more likely to reduce their BMI as they become older, leading to the positive effect of income disappearing. *DENS* shows negative signs in all estimations for females and is statistically significant at the 1% level only for 16-year-old females, while, for males, the sign of *DENS* is variable and statistically insignificant. The results of *DENS* are consistent with the argument presented in the Introduction. *BSPORT* and *GSPORT* yield negative signs and are statistically significant for all estimations.

With respect to Table 3, it can be seen that *INCOM* has significant positive signs in columns (1), (2), (3) and (5). With respect to estimations for males, the value of the coefficient in column (3) is smaller than those in columns (1) and (2), which is not consistent with the results of Table 2. A reduction in sample size appears to result in this inconsistency. However, these indicate that the positive effects of income level on BMI exist regardless of age group, whereas the positive effect disappeared when females became older. *DENS* continued to have a negative sign and be statistically significant at the 1% level for 16-year-old females while it was not statistically significant in other estimations.[8] *BSPORT* and *GSPORT* continue to yield negative signs and are statistically significant for all estimations. The combined results of *BSPORT* and *GSPORT* shown in Tables 2 and 3 are consistent with the prediction that participation in sports reduces BMI by burning calories. *CALO* and *AFAT* both had positive and negative signs and were statistically insignificant, with the exception of AFAT in column (5), indicating that lifestyle has a greater influence on BMI[9] than calorie intake.

[8] The fact that BMI of adolescents in urban areas is more likely to be lower than in rural areas is observed in the United States (Auld and Powell, 2009).

[9] Zellner et al. (2007) found recently in Poland that the relationship between calorie intake and BMI weakened after 1985, and asserted that the increase in the prevalence of overweight and

Self image plays an important role in determining body weight and BMI (Costa-Font and Gil, 2004). Western standards of beauty, strongly emphasizing thinness, have spread across transitional Eastern European countries via the mass media, influencing the teenage lifestyle (Vignerova et al., 2007). As argued by Chrzanowska et al. (2007), the inflow of American culture caused girls to desire to be thin and the boys to be muscular. The tendency for girls to be more sensitive to BMI in urban than in other areas implies that body self-image is partly promoted through abundant information concerning fashion and social interaction in urbanized, more densely populated areas. Japanese society became strongly influenced by American culture in the postwar period. The evidence provided in this study suggests that Japan experienced the same lifestyle changes as Eastern Europe. Behind this phenomenon, the inflow of American culture in the postwar era changed the perception of beauty and so led to a beauty premium in the labor and marriage markets in Japan. The higher competitive pressures in more urbanized areas are likely to increase the incentive of schoolgirls to reduce their weight to gain more acceptable body proportions.

5. Conclusion

Average BMI is relatively low in Japan, but has increased since the 1990s. Using Japanese prefecture-level panel data, this paper aimed to ascertain the determinants of teenage BMI by age and sex. Major findings from the random effects estimation were as follows: (1) BMI has increased consistently during the period in 10–16-year-old males and in 10–13-year-old females. This tendency, however, was not observed in 16-year-old females; (2) BMI was not influenced by population density in males or younger females. However, the BMI of 16-year-old females was markedly lower in more densely populated urban areas.

These findings suggest that girls who reach adolescence have a greater incentive to diet, and this tendency is more distinct in more urbanized areas. Self-image, influenced by the inflow of American culture in the postwar era, appears to generate a beauty premium in the labor and marriage markets. Consequently, competitive pressure leads older teenage girls to reduce their BMI and to obtain a slimmer body in urbanized areas.

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obesity not only arises from an increased energy intake, but also reflects a more inactive lifestyle of children and adolescents.

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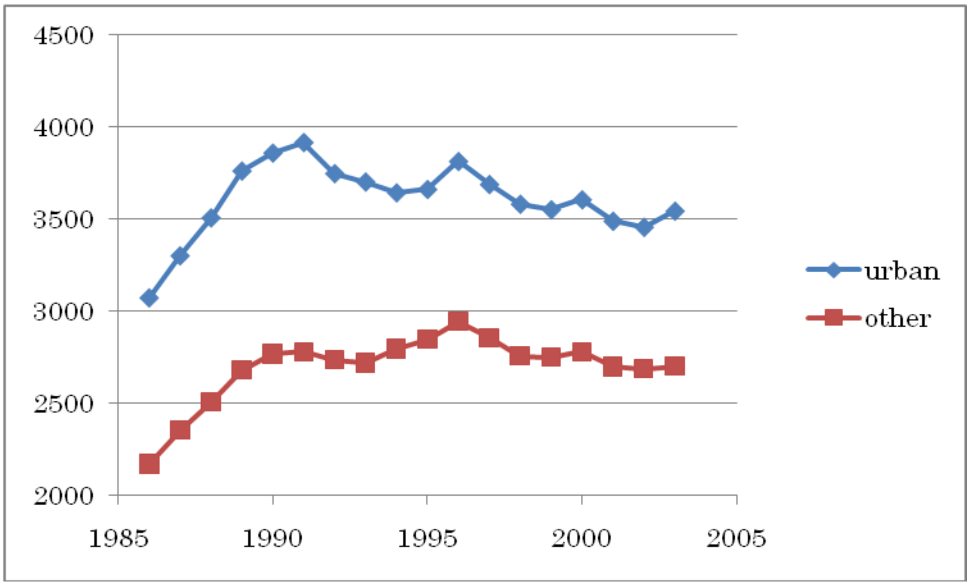
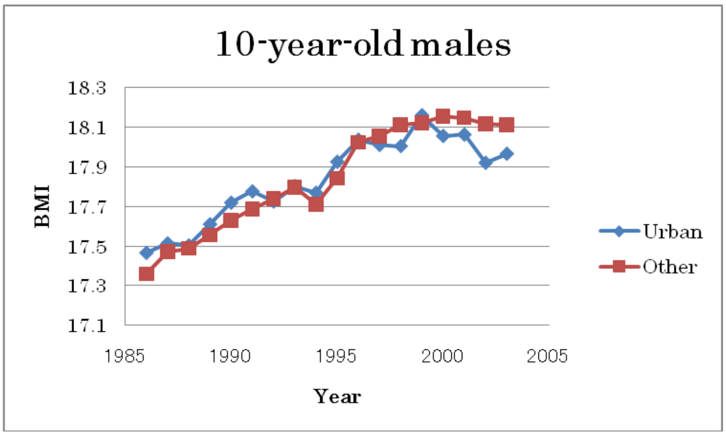
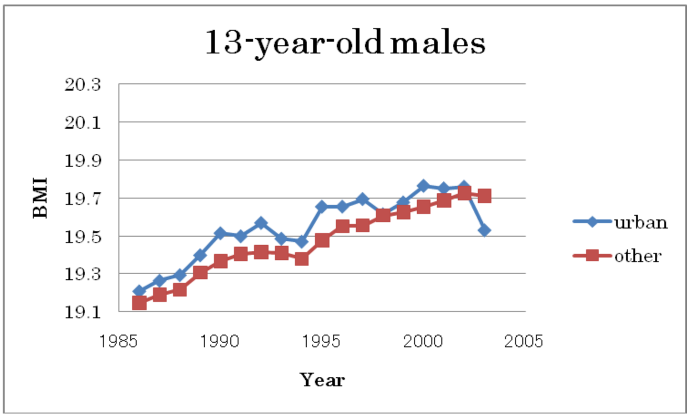


Fig. 1. Comparison of *per capita* income between urban and other areas.

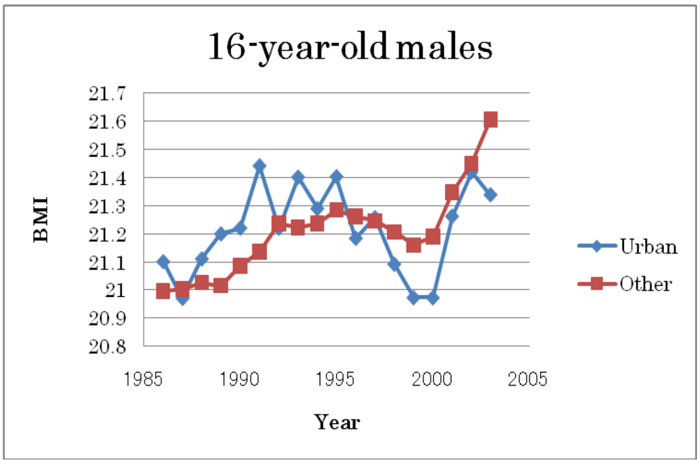
Note: Urban areas comprised the top 4 most densely populated prefectures in 1988: Tokyo, Kanagawa, Aichi, and Osaka.



(1) 10-year-old males



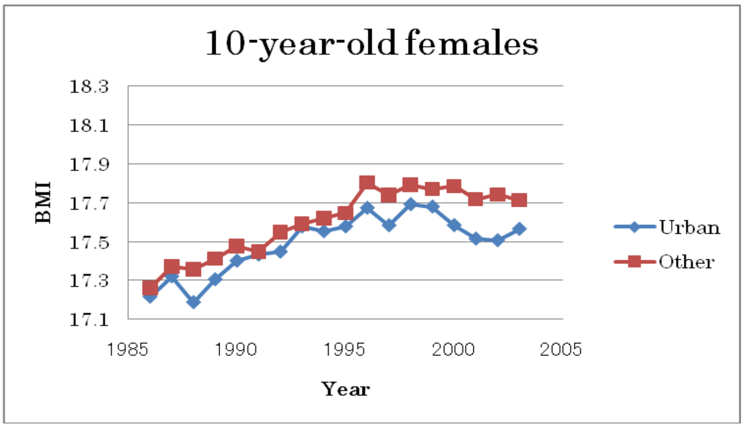
(2) 13-year-old males



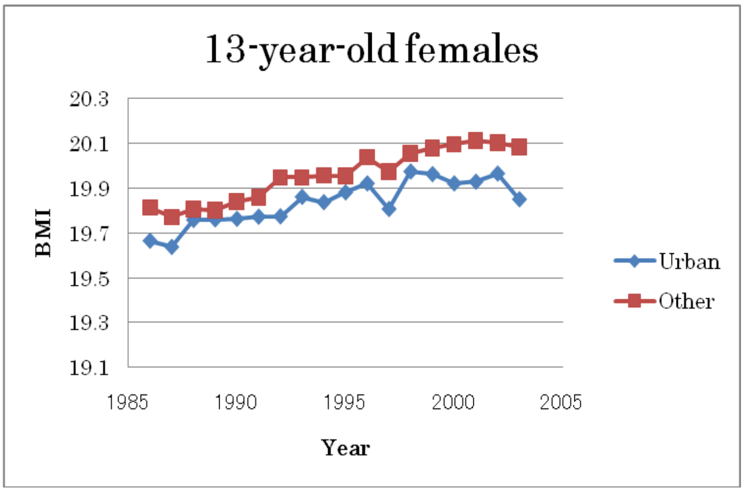
(3) 16-year-old males

BMI: body mass index.

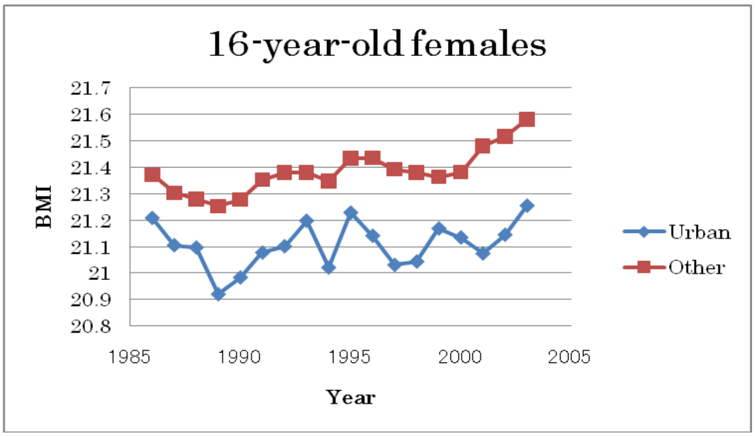
Fig. 2. Comparison of male adolescent BMI between urban and other areas by age.



(1) 10-year-old females



(2) 13-year-old females



(3) 16-year-old females

BMI: body mass index.

Fig. 3. Comparison of female adolescent BMI between urban and other areas by age.

Table 1

Definition and basic statistics of independent variables used for the estimation

Variables	Definition	Mean	Standard deviation
INCOM	Annual *per capita* income (in thousands of yen)	2774	431
DENS	Population density (population /habitable land).	13.5	15.7
BSPORT	Index for sports activity in males over 10 years old in 1996 (%). (Active sporting male population/total male population)	80.3	2.8
GSPORT	Index for sports activity in females over 10 years old in 1996 (%) (Active sporting female population/total female population)	68.2	4.0
CALO	Calorie intake per day (kcal)	2015	99
AFAT	Animal fat intake per day (g)	27	2
Y1988 –Y2003	Year dummies	———	———

Source: Index Corporation (2006)

Note: Sports active population is defined as the population who took part in a sport at least once a year (from the Ministry of Internal Affairs and Communications (MIAC), 1997).

Table 2
Determinants of BMI by age group and sex (Random Effects Model)

	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
	10 years	13 years	16 years	10 years	13 years	16 years
INCOM	0.21	0.32**	0.34**	0.10	0.41*	0.10
	(1.13)	(2.33)	(2.46)	(0.86)	(1.92)	(0.60)
DENS	0.006	-0.03	0.0008	-0.01	-0.02	-0.06**
	(0.27)	(-1.41)	(0.04)	(-0.97)	(-0.96)	(-2.60)
BSPORT	-3.43**	-1.71**	-3.32**			
	(-2.66)	(-2.55)	(-2.73)			
GSPORT				-1.44**	-2.60*	-1.32**
				(-2.32)	(-2.02)	(-2.36)
Y1986	Reference group			Reference group		
Y1987	0.09**	0.08**	0.01	-0.04**	-0.03**	-0.07**
	(3.19)	(3.39)	(0.87)	(-3.00)	(-0.81)	(-2.47)
Y1988	0.09**	0.04	0.02	-0.01	-0.02	-0.10**
	(2.48)	(1.25)	(0.95)	(-0.43)	(-0.53)	(-2.59)
Y1989	0.15**	0.08*	0.09**	-0.02	-0.05	-0.15**
	(3.19)	(1.97)	(2.97)	(-0.66)	(-0.97)	(-3.31)
Y1990	0.22**	0.13**	0.15**	0.009	0.001	-0.12**
	(4.09)	(3.51)	(3.66)	(0.29)	(0.03)	(-2.41)
Y1991	0.27**	0.11**	0.18**	0.02	0.06	-0.05
	(4.85)	(2.49)	(4.30)	(0.78)	(1.00)	(-1.10)
Y1992	0.32**	0.21**	0.20**	0.11**	0.14**	-0.02
	(6.78)	(5.32)	(4.94)	(3.30)	(2.36)	(-0.44)
Y1993	0.38**	0.26**	0.19**	0.11**	0.15**	-0.01
	(7.21)	(6.88)	(5.29)	(3.39)	(2.84)	(-0.29)
Y1994	0.29**	0.28**	0.15**	0.12**	0.14**	-0.06
	(5.81)	(6.66)	(3.79)	(3.60)	(2.34)	(-1.15)
Y1995	0.42**	0.30**	0.25**	0.12**	0.19**	0.03
	(8.42)	(6.40)	(6.11)	(2.93)	(2.95)	(0.62)
Y1996	0.59**	0.44**	0.30**	0.19**	0.13*	0.02
	(10.6)	(8.97)	(7.18)	(4.91)	(1.94)	(0.37)
Y1997	0.63**	0.38**	0.32**	0.13**	0.14*	-0.02
	(11.0)	(8.93)	(7.08)	(3.72)	(2.22)	(-0.42)
Y1998	0.68**	0.45**	0.38**	0.22**	0.10*	-0.02
	(13.3)	(13.6)	(9.28)	(6.09)	(1.65)	(-0.51)
Y1999	0.71**	0.43**	0.40**	0.24**	0.05	-0.03
	(14.4)	(9.94)	(10.7)	(7.31)	(0.84)	(-0.61)
Y2000	0.73**	0.43**	0.43**	0.25**	0.07	-0.02
	(12.0)	(12.1)	(10.3)	(7.14)	(1.16)	(-0.40)
Y2001	0.73**	0.38**	0.47**	0.27**	0.25**	0.06
	(14.4)	(9.27)	(10.5)	(8.80)	(4.15)	(1.46)
Y2002	0.69**	0.40**	0.51**	0.27**	0.36**	0.10*
	(13.4)	(10.8)	(13.3)	(8.60)	(6.26)	(2.18)
Y2003	0.68**	0.38**	0.47**	0.024**	0.50**	0.17**
	(12.7)	(9.36)	(11.8)	(8.41)	(7.48)	(3.39)
Observations	846	846	846	846	846	846
Groups	47	47	47	47	47	47
Hausman test	Yes	Yes	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are z-statistics obtained using the delta method. * and ** indicate significance at 5 and 1 percent levels respectively (one-sided tests). “YES” means that there is no systematic difference between the result of the fixed effects estimation and that of the random effects estimation. Constant is included but not reported because of limited space.

Table 3
Determinants of BMI by age group and sex. (Random Effects Model)

	Males			Females		
	(1)	(2)	(3)	(4)	(5)	(6)
	10 years	13 years	16 years	10 years	13 years	16 years
INCOM	0.34*	0.37**	0.32**	0.05	0.55**	0.10
	(1.91)	(2.76)	(2.52)	(0.36)	(2.39)	(0.54)
DENS	0.008	-0.03	0.01	-0.01	-0.02	-0.06**
	(0.04)	(-1.45)	(0.48)	(-0.54)	(-1.17)	(-2.60)
BSPORT	-3.79**	-1.82**	-3.43**			
	(-2.95)	(-2.71)	(-2.86)			
GSPORT				-1.42*	-2.77*	-1.22*
				(-2.24)	(-2.10)	(-2.09)
CALO	-0.13	0.08	-0.09	0.04	-0.15	0.09
	(-0.61)	(0.55)	(-0.67)	(0.29)	(-0.98)	(0.33)
AFAT	0.08	0.05	0.07	0.003	0.16*	-0.01
	(1.10)	(0.78)	(0.95)	(0.06)	(1.70)	(-0.16)
Observations	724	724	724	724	724	724
Groups	47	47	47	47	47	47
Year dummies	Included	Included	Included	Included	Included	Included
Hausman test	Yes	Yes	Yes	Yes	Yes	Yes

Note: Numbers in parentheses are z-statistics obtained using the delta method. * and ** indicate significance at 5 and 1 percent levels respectively (one-sided tests). "YES" means that there is no systematic difference between the result of fixed effects estimation and that of random effects estimation. Constant and year dummies are included but not reported because of limited space.