Some students are bigger than others, some students' peers are bigger than others student's peers (*)

Toni Mora
Universitat Internacional de Catalunya & Barcelona Institute of Economics

Joan Gil
Department of Economic Theory & CAEPS (Universitat de Barcelona)

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Abstract:

Empirical evidence on peers' influence has shown the presence of partial effects. The selection problem has been usually solved by means of random (or quasi-random) variation of peers. In our case, we make use of a unique survey containing information about: personal data, school characteristics, parental background and the real composition of cliques within classrooms. In doing so, we emphasize on the importance of asymmetric peer effects (reciprocating relations) on BMI levels for identification issues. Additionally, we seek further on this examining whether average classmates/cliques' anthropometric features (symmetric effects) have also a significant impact on individual BMI.

Keywords: Peer effects, Adolescent behaviour, Obesity/overweight
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Correspondence to: Toni Mora, School of Economics and Social Sciences, Universitat Internacional de Catalunya, Immaculada, 22, 08017, Barcelona (Spain) Phone 0034 932541800 (4511) Fax 0034 932541850. Email: tmora@cir.uic.es

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1. Introduction

Obesity is a global public health problem affecting not only the wealthy nations. The rapid increase of the obesity epidemic in the last decades is particularly alarming in children and adolescents, passing the condition into adulthood and creating a growing health burden for the next generations. According to the CDC (2010) report the prevalence of overweight in US teenagers, aged 12-19 years, has more than doubled in the last decades reaching 17.8% by 2005-2006. This trend is also observed in the European countries. The Health Behaviour School-aged Children survey conducted in 2001-02 indicated that 24% of the 13-year-old girls versus 34% of boys, and 31% of 15-year-girls versus 28% of boys were overweight in Europe, although a geographical pattern can be observed among European countries.[1] Empirical evidence documents that overweight during childhood and adolescence increases the risk of hypertension, cholesterol, sleep apnoea, diabetes type 2, low self-esteem or discrimination in education and work settings.

Research on the determinants of children/adolescent overweight has pointed out to the influence of parents, the role of food availability and prices or the emergence of an "obesogenic environment" through changes in home, school, transport and urban policies, commercial food activities, etc., inducing physical inactivity and poor dietary practices (Koplan et al., 2005). In the last decade or so, a new body of literature has emerged in the field of health economics -connected to the social interactions' framework- placing emphasis in the influence of peers on adolescents' health status. Several papers have suggested that peer friends or classmates have a significant positive impact on health related behaviours among youth such us smoking, binge drinking or illicit-drug use (e.g., Norton *et al.*, 1998; Gaviria and Raphael, 2001; Powell *et al.*, 2005; Lundborg, 2006; Clark and Lohéac, 2007). But, certainly, less is known about the effect of social networks on the obesity status of the population. The exceptions are, on the one hand, the study of Christakis and Fowler (2007) who, using a social network of adult people with repeated measurements over a period of 32 years, concluded that social networks facilitate the spread of obesity (e.g. ties between friends, siblings, spouses, neighbours). On the other hand, the works of Trogdon et al. (2008) and Renna et al. (2008) documenting a positive

[1] Overweight for these age groups is highest in the UK and in other southern European counties like Greece, Italy, Portugal and Spain. The Scandinavian and the central European counties show lower levels (WHO, 2007).

influence of friends' weight on adolescent body weight using a longitudinal survey of health related behaviours for a sample of American adolescents.

The paper seeks to study the role of peer effects in adolescent body weight (proxied by the BMI) in a radically different socio-cultural context. Namely, the goal is assess to which extent the influence of peers on adolescent weight in a typical southern European country differs from the peer effects observed in the United States, two geographical areas characterised by different economic, socio-cultural and environmental patterns. This is even more relevant when international data on health-related behaviour among adolescents evidence that peer group pressure tend to vary greatly across countries. Interestingly, the HBSC 2001/2002 data show the existence of significant cross-country differences in the size of friendship groups, which is taken as a proxy indicator of exposure to peer influences (WHO, 2004). While adolescents in English-speaking countries (Canada, England, Scotland, the United States and Wales) and Scandinavian countries report high percentages of groups containing three or more close friends of the same gender (around 80-90%), in Mediterranean and eastern European countries such percentages are far lower.[2] The data also indicates that the amount of time young people spend with their friends (i.e., a strong predictor of peer influence) vary widely across countries. In principle, one could expect that frequent meeting with friends is associated with having more changes to initiate or maintain different types of risky behaviours.[3] Among the 13-year-olds, the percentage of boys (girls) meeting with friends four o more evenings per week is 29% (25%) in the US, being these shares higher 41% (32%) in the case of Spain.[4] Note that behind this geographical variation of social networks among adolescents persist cross-country differences in socio-cultural, religious, life-styles and environmental patterns which influence the identity and socialization process of youth and, thus, the behaviour of peer groups.

We use data from a unique survey of secondary school students in Catalonia (Spain) conducted in 2008 containing a rich set of personal data, school characteristics and parental background. The relevant issue is that students were asked to identify their specific friends

[2] For the 13- (15-) year-old boys, the share with three o more close friends is around 83% (77%) in the US but only 63% (57%) in Spain. Among girls of the same age, such frequencies are 89% (81%) in the US and 60% (51%) in Spain. The data also shows a cross-country differential pattern by gender.
[3] Although peer contact is also important for the development of protective factors against unhealthy life-styles.
[4] These country differences are however shortened among the 15-year-old individuals as meeting with friends increases gradually with age.

in class (without limitations in the number of peers to nominate or their gender when selecting) which allows us to distinguish three kinds of friendships: all nominated friends, mutual friends and non-mutual friends. After accounting for a large set of controls, controlling for a combination of school-and neighbourhood specific fixed effects, IV estimation (i.e., using friend's parents' background characteristics as instruments) and alternative definitions of peers, our results point out peers has an effect. The paper is organized as follows. Next section discusses the theoretical framework of peer effects. Section 3 describes the data and presents the empirical methodology, whereas Section 4 reports the main results and finally section 5 concludes.

2. Social interactions within classroom

Empirical evidence of peer effects suffers from what is known as the reflection problem (Manski, 1993). Peer effects are split into three different kinds of effects: (i) endogenous effects (consequences of individual' decisions within a peer group on the other peers); (ii) correlated effects (peers having a common trait, such as teacher's tuition configuration, which obviously affects the peer group behaviour) and; (iii) exogenous or contextual effects (individual's actions depend on the features of their peers). One of the main challenges when analyzing peer effects is the fact that schools, classrooms and peer groups are not formed randomly.[5]

The main drawback of these empirical approaches relates to solving identification problems because of behavioural effects simultaneity. This selection problem has been usually solved by means of random (or quasi-random) variation of peers when analyzing peers influence on high school grades (Hanushek *et al.*, 2003; Hoxby, 2000; Lavy and Schlosser, 2007). It is obvious that co-variations in the outcomes of an adolescent and his/her classmates or even schoolmates are subject to a common class-level or school-level environment. Thus, the estimation of peer's influence on teenagers' body weight has mainly relied on an IV strategy using biological relatives' BMI (e.g. Renna *et al.*, 2008 or Trogdon *et al.*, 2008 both making

[5] On one hand, the usual solution has relied on exploiting experimental or quasi-experimental designs to separate social effects in the classroom (which are the combination of endogenous and exogenous peer effects), e.g. those arising from misbehaviour or satisfaction with school (see Lavy and Schlosser, 2007), individual motivation or effort from correlated effects (Sacerdote, 2001; Zimmerman, 2003; Hanushek et al., 2003; Ammermueller and Pischke, 2006 and; Gibbons and Telhaj, 2006, amongst others). On the other hand, using observational data, recent literature has focussed on finding out exogenous variations for explaining the formation of peer groups. Following Hoxby (2000)' strategy, few recent papers (such as Lavy and Schlosser, 2007 or Proud, 2008), have made use of the variation in the distribution of females across cohorts using the proportion of girls within a grade as a measure of the peer group.

use of the National Longitudinal Study of Adolescence Health) or introducing school fixed effects (Trogdon *et al.*, 2008).

Our approach differs in the definition of peers twofold. First, we are able to disentangle the influence on pupil's BMI of all the specific friends within classroom out of the whole composition of classroom. Second, in doing so, asymmetries in classmates' relationships are considered. On one hand, students may interact with others showing different features. For instance, a fat student maybe identifies three specific non fat students as friends but not all his/her fat classmates. On the other hand, maybe, two out of these three students cannot be considered as real peers. That is, in some cases, one student identifies another student as a friend, but that friend does not reciprocate by also identifying him. Assuming in these asymmetric cases that peer effects flow in one direction – from 'friend' to 'non-friend' – allows us to estimate peer effects in the classroom that occur from interaction with self-reported friends, rather than from interaction with overall groups.

Then, we are able to find out which of these peers exposures definitions are really influencing student's BMI. On one hand, our results indicate that considering non-reciprocating are not determining. On the other hand, nominated friends and classmates have a very similar impact. Our argument is that students not only mirror on their specific friends within cliques but also on their classmates.

Treating peer effects as a consequence solely of predetermined peer features, such as ability, only captures any effect including relationships that may exist. But, do we know how are peers formed in general? Theoretically, making up peers arise through unobservables such as leisure activities or lifestyle conditions. Whilst school and class composition is determined by neighbourhood characteristics such as average income per capita, the make-up of the real reference group (peers within classroom) relies on other sociological factors. Bishop *et al.* (2004) affirm teenagers interact with each others based on time allocation between activities according to cliques' norms (such as extracurricular activities or socializing friends). Therefore, it is strongly relevant to estimate peers influence by means of databases that allow accounting for nominated friendship relationships.

Brock and Durlauf (2001) point out that individuals choose based on a baseline utility, which is common across individuals in the same reference group, and on the distance

between their selection and the average expected action in that population. Specifically and regarding body weight, Burke and Heiland (2007) developed a model of optimal weight including social dynamics since individuals are concerned with being normal in relation to their reference group. Then, children may look at their circle of friends when deciding their body weight. Anyway, note that adolescents mirror on others when choosing healthy/unhealthy behaviours which also conditions individual body weight.

Notwithstanding, cliques are not entirely closed tight-knit circles. That is, asymmetries in groups' relationships appear. Our proposal is to use the self-identified peers and to observe whether exist or not reciprocities within relationships. Thus, we are able to identify not only every dyad but also one-sided relationships taking place within classroom. Besides this, and although cliques' relationships are our main peers' exposure measure (either reciprocating or non-reciprocating), we also exploit information regarding classmates since social norms influence above and beyond one's immediate circle of friends and especially for girls (Eisenberg *et al.*, 2005). Although it is more likely that students mirror on closer friends, interactions also arise within classrooms and schools. Indeed, Catalan students spend in classrooms a large portion of weekdays, such in other countries. In addition, class-size (twenty five students per class at secondary and thirty at upper secondary) allows so many interactions with either classmates or schoolmates apart from their own cliques.

3. Data and Method

We use data from a unique and representative survey of secondary school students in Catalonia, one of the richest and more populated Spanish regions, collected between February and June of 2008. The survey was targeted at secondary students of four specific academic years: the last two years of compulsory secondary education (14-16 years old) and the two years of upper secondary education (16-18 years old). As the questionnaire is completed by the student, math teachers were approached to participate in the survey and help with student data collection. The questionnaire (supplied on-line with randomness in questions appearance) contained six blocks of questions: personal data (including anthropometric information), scholar characteristics, math's teaching questions, parental

background information, consciousness and motivation questions and lifestyle habits.[6] The final sample contains information of more than 3,000 students of 91 high schools.[7]

Our cross-sectional dataset presents a number of advantages over data used in previous studies. First, we define peer groups using nominated friends within the classroom. Few other studies have been able to define peer pressure at such a fine level.[8] Second, in contrast to the Add Health data where students were limited to list up to 10 friends (5 male and 5 female), in our dataset students were asked to identify or nominate a free number of close friends in the classroom. Third, as we have information on all listed friends we can consider more sophisticated social networks like asymmetries in classmates' relationships. Thus, similarly to Christakis and Fowler (2007), we can distinguish three different kinds of friendships: i) "all nominated friends" in which the group is formed by all listed friends chosen by each adolescent, ii) "mutual friends" where the nomination is reciprocal (i.e., identification flows in both directions) and the peer group is just composed by those who also reciprocates the friend relationship and iii) "non-mutual friends" or "non-reciprocating friends" in which the reference group does not identify the adolescent as a friend.[9] Fourth, note that in contrast with the Framingham Heart Study (but similar to the Add Health) our social networks are more connected and less varied as they take place within the same classroom (Cohen-Cole and Fletcher, 2008). Five, the data allows us to address the issue of endogenous sorting. While students cannot decide which class to participate in and, then, cannot sort themselves into classes with pupils similar to themselves, sorting across schools may take place through parents' decisions regarding where to live based on the quality of high schools (Lundborg, 2006).[10] In order to account for this effect our estimations will include school- and neighbourhood-specific fixed effects. Finally, as cited above the data collects information regarding juvenile behaviour and social networks from an EU southern country characterised by a socio-cultural and environmental context that favours

[6] Since not all high schools had computer room facilities or enough time schedules, some participating schools received the questionnaire in paper format. None of the students had access to the questionnaire prior to responding which permits us to avoid attrition effects, although students were free to not respond some questions.

[7] As there could be sample selectivity due to the under-representation of some specific areas or schools based on their managerial characteristics (public, semi-private or private), some administrative information was asked to the Catalan Ministry of Education for sample representing reasons.

[8] The exceptions are Clark and Lohéac (2007), Trogdon *et al.* (2008) and Renna *et al.* (2008) using the National Longitudinal Study of Adolescent Health (Add Health) and Christakis and Fowler (2007) making use of the Framingham Heart Study.

[9] Trogdon *et al.* (2008) judges the existence of just unidirectional friendship nomination in the Add Health as a serious limitation of the study.

[10] In Spain schools do not sort students across classes according to ability.

an intense social life which ultimately affects the formation and dynamics of peer group pressure.

The dependent variable of this study is adolescent BMI.[11] Since weight and height information is self-reported by each interviewed student, some potential measurement error could be present in our data, as is acknowledged by the literature.[12] Thus we proceed by adjusting self-reports on height and weight by applying a standard correction procedure (e.g. Cawley, 2000; Chou *et al.*, 2004; Cawley and Burkhauser, 2008). To that end we estimated the relationships between measured and self-declared weight (height) found using a sample of adolescents of the same age-group (based on the Catalan Health and Examination Surveys, 2006)[13] and these values were transported to our dataset in order to correct self-declared weight and height and, accordingly, BMI values.

The empirical model for (corrected) BMI of pupil *i* with peer group *j* in class *c* and in school *s* is,

$$BMI_{ijcs} = \beta_0 + \beta_1 BMI_{jcs} + \beta_2 X_{ics} + \lambda_s + \lambda_n + \varepsilon_{ics} \qquad (1)$$

where our variable of interest (BMI_{jcs}) is the average BMI among friend peers attending the same classroom,[14] X_{ics} represents considered covariates, λ_s and λ_n are school- and neighbourhood-specific fixed effects and ε_{ics} is the individual-specific error term. Particularly, we consider two alternative measures of peer groups: the average BMI of "all nominated friends" and the average BMI of "mutual friends". Figure 1 presents the distribution of these two covariates and shows the existence of enough variation needed for identification reasons. Although these two definitions of friends' weight are arguably a better measure of peer pressure, they are likely to be endogenous. Thus in addition to instrumental variable estimation, we alternatively define the average BMI of all classmates since it is considered to be a more exogenous social network effect as long as the assignment to a certain class or grade level is determined exogenously by year of birth. Of

[11] The BMI measure is calculated as the ratio of individual weight, measured in kilograms, to squared height, measured in metres.
[12] In general high school students of both sexes consider themselves taller and thinner than they actually are (e.g. Farré-Rovira *et al.*, 2002; Danubio *et al.*, 2008).
[13] OLS regressions of measured height (weight) on self-reported height (weight) gender, age and age square were derived.
[14] Note that adolescent own BMI was subtracted from the computation of peers' weight.

course, this broader definition of peer group is not expected to generate the same type of social influence than friend-level peer pressure, perhaps operating through the imposition of a BMI standard or social nom (e.g., Burke and Heiland, 2007).

[Insert Figure 1 about here]

As controls, we make use of a large list of covariates (X_{ics}) including adolescent characteristics (age, gender, immigrant status, smoking status, alcohol consumption, sleeping time, number of hours reading books and watching TV), family characteristics (family type, difference in years between the mother and the adolescent, mother's education and health status, parental involvement in homework)[15] and some class-level characteristics (percent of mothers with university education; percent of female students and percent of female students within cliques).

Following the thesis of Heckman *et al.* (2006) that (latent) non-cognitive skills, along with cognitive skills, are equally important factors for a successful social and economic life and in adopting less healthy risky behaviours, note that the econometric specification includes a measure of individual consciousness. Given that the questionnaire asked information on consciousness (one out of the five components of personality, the one related to ability), this variable was constructed through a factorial analysis.[16] Although other measures can be affected by peers, personality traits are specific to each individual and are not so permeable to be influenced. Then we are able to include this covariate as a substitute for student fixed effects and constitutes a different source of ability. Table 1 presents the definitions of the regressors used in the estimation of the empirical model.

[Insert Table 1 about here]

[15] Other covariates like adolescent's physical exercise, health status and extracurricular activities or father's health status were not included for their non statistical significance. Thus, these and other covariates finally were not considered for efficiency reasons. For instance, we controlled in fist stages by means of the number of nominations such in Calvó-Armengol *et al.* (2009) which allows us to control for unobserved network-specific components.

[16] We conducted several interviews with psychologists to include the relevant questions due to time constraints on applying the survey. We followed Alonso-Tapia and Arce-Sáez (1992) being specific for Spanish teenagers. We computed Cronbach's alpha statistic for the scale formed from the pairs of variables (0.76). A factorial analysis allowed us to construct two factors related to personality. The Kaiser-Meyer-Olkin measure of sampling adequacy depicts a meritorious value (0.81). Accordingly, factors' scores were re-scaled to variables ranging from 0 to 1 so indicating the degree of personal consciousness.

As noted above, to control for the presence of correlated effects we use school-specific fixed effects, λ_s (e.g., Lundborg, 2006; Clark and Lohéac, 2007; Trogdon *et al.*, 2008 and Renna *et al.*, 2008) and also neighbourhood fixed-effects, λ_n (captured by the residential post zone code and the school centre post zone code).[17] This set of fixed effects would eliminate any unobserved school or neighbourhood characteristic that may influence the weight of the adolescent and the weight of his/her friends attending the same classroom and school or exposed to the same local environment. For instance, nutrition school polices or physical activities in the curriculum (although the latter can be controlled by classmates' average physical activity) shared by all students will lead to correlated effects.[18]

To address the issue of the potential endogeneity or bi-directionality of the peer relationship we estimate equation (1) using instrumental variable (IV) estimation. Following standard practice (Case and Katz, 1991; Gaviria and Raphael, 2001; Lundborg, 2006; Clark and Lohéac, 2007; Trogdon *et al.*, 2008 and Renna *et al.*, 2008) we assume that contextual effects are non-existent and thus average background characteristics of peers can be used as instruments. While some studies have used friend's parental obesity as an instrument for peer influence (Cawley 2000, 2004; Brunello and D'Hombres, 2007; Trogdon *et al.* 2008 or Renna *et al.* 2008), other papers have relied on other friends or classmates characteristics (e.g., living in single-parent families or in an apartment, parents born outside the country, parental health status or college education). Given our database, we instrument friends' BMI by using the average of friends' mothers' years of education and the average classroom friends' age. These two variables are presumed to be valid instruments as long as we assume that background characteristics of peers do not have a direct impact on the adolescent's weight, but an indirect influence through their impact on the BMI of the peer group. Obviously, we conducted several tests to ensure the validity of the instruments.

4. Empirical results

4.1 Descriptive evidence

The average BMI of adolescent respondents in our sample is 21.81 and reaches a figure of 25.45 among the overweight group, which corresponds to an overweight (includes obesity)

[17] Weight and BMI display dissimilarities based on the district of residence - see Mora (2009) for observed differences within the city of Barcelona which is representative for the Catalan case.
[18] Lunch diets in Catalonia are controlled by the regional government through regular inspections.

prevalence rate of 16.5%, close to the Spanish levels (17%) but below US levels (17.6% for adolescents aged 12-19).[19] Interestingly, both the average BMI of "mutual friends" (21.72) and "all nominated friends" (21.78) peer groups are slightly lower than the individual BMI of the whole sample, being such differences statistically significant. This evidence roughly indicates that fatter students are less prone to be nominated by the rest of students and hence peer groups have a slightly lower body weight.

Note that the mean number of "total nominated friends" in our dataset is 6.59, being this figure lower among male friends (6.36) than their female counterparts (6.81). As this difference is statistically significant (p-value=0.00) we will split the sample by gender when we explore peer impact on individual BMI. As expected, the size of the "mutual friends" peer group is slightly lower with an average number of 4.17 friends. About 10.8% of students do not list anyone as a friend. To have a precise idea of the variability of these peer pressure covariates, Figure 2 presents the distribution of friends' nominations for "all nominated friends" (panel A) and "mutual friends" (panel B) by BMI status. The data show that overweight students tend to nominate a fewer number of close friends (6.73) than their normal-weight counterparts (7.08) and get minor reciprocity from their nominations than the normal weighted counterparts (see Figure 2, panel B). Computing the ratio between the number of students' nominations as friends and the number of times being nominated, overweighted shows a figure of 0.98 whilst normal weighted displays 0.75. Surely, this result will condition inference results when asymmetries are considered.

[Insert Figure 2 about here]

Students may self-select their relationships within their classroom according to either their academic skills or their attitudes towards academic effort intentions but not related to their anthropometric measures. The later would rely on the idea of weaker students having more close interaction with other weak students than with strong students (Kang, 2007). In this regard, the share of overweighted students nominating and getting reciprocity from those

[19] The overweight category was defined using the age- and gender-specific international cut-off points calculated by Cole *et al.* (2000). Following recommendations of the International Obesity Task Force, these authors by pooling cross-sectional data on BMI for children from six countries (Brazil, Great Britain, Hong-Kong, the Netherlands, Singapore and the United States) and using the centile based method (ensuring that at age 18 they matched the adult cut off of 30 kg/m^2) were able to calculate BMI cut-off points for overweight and obesity for children aged 2-18 years.

similar to them is hardly dissimilar than the percentage displayed by their normal weighted counterparts.

4.2 Econometric results

Table 2 reports a set of OLS estimations of equation (1) accounting for several econometric specifications and distinguishing between the two alternative definitions of peer friends. Inference analysis is based on robust standard errors accounting for clustering at the classroom level. The first two equations, which exclude any controls and fixed effects, evidence that the BMI of the adolescents is positively related to the BMI of his/her friends, although as expected the "all nominated friends" peer effect is greater than that of the "mutual friends". An increase of 1 unit in the average BMI of "mutual friends" ("all nominated friends") is associated with a 0.11 (0.17) point increase in the respondent adolescent BMI. These estimations translate into marginal effects of 10.51% and 17.07%, respectively. Next, in equations (3) and (4) we present the regressions including adolescent and family controls. The results indicate that friends' weight is correlated with an adolescent's own weight even after controlling for such list of covariates. As it is expected, peer effects magnitude considerably diminishes although it remains statistically significant. Now, estimated marginal effects are 9.33% and 10.79% which means that both effects (mutual and all nominations) are much closer than previously. Equations (5) and (6) include as additional controls classroom-level characteristics. We find that "mutual friends" is no longer statistically significant whilst "all nominated friends" hold its positive and significant effect on adolescent BMI, with an estimated marginal effect of 9.08%. Finally, in a further step, we estimate the last two equations of Table 2 adding school and neighbourhood-specific fixed effects under the assumption that weight or BMI may display some disparities depending on the school and/or district of residence. Similarly, families might sort into school areas based on amenities (e.g., recreation areas and parks) which could be correlated with adolescent weight (Trogdon *et al.*, 2008). Actually, neighbourhood characteristics condition the type of extracurricular activities that can be performed by adolescents or the kind of amenities correlated with weight (i.e., sport facilities or recreation parks). We captured these effects by the residential post zone code and the school centre post zone code. Our results evidence that "all nominated friends" peer effect turns out to be irrelevant in explaining student's BMI.

[Insert Table 2 about here]

Results for other covariates indicate that females tend to have lower BMI and, on the contrary, older adolescents tend to have higher BMI. Interestingly, smoking habitually, sleeping time and having no familiar help in homework is negatively associated with adolescent BMI, but reading activity and watching TV is positively associated with teens bodyweight. Finally, as expected mothers with low levels of education is correlated with higher levels of adolescent BMI. Hereafter the peer group coefficients are the focus of the rest of the paper.

We present in Table 3 the results of the IV estimations to control for the endogeneity nature of our variable of interest. We decide to only instrument "all nominated friends" peer pressure since it is the most appropriate level of peer impact once we take into account that student in general are affected not only by their mutual relationships. Although some of his/her peers do not correspond in reciprocity, the student is influenced by those who he/she has nominated. We use abovementioned instruments, namely, average of friends' mothers' years of education and the average classroom friends' age. All regressions show that our instruments are valid. Collective statistical significance (F-test for the first regression) is considerably high and all of them show sufficient explanatory power. Likewise, Hansen-J test and Kleibergen-Paap Wald F statistic validate our instruments. The first equation displays IV results on the entire sample accounting for the complete list of controls and school- and neighbourhood-specific fixed effects. Interestingly, the "all nominated friends" peer effect is positive and statistically significant, indicating that when mean BMI of adolescent's friends is 1 BMI unit higher then adolescent BMI is higher by 0.53 units (very similar to Trogdon et al. (2008) estimates). Then, we can argue that OLS estimation results are underestimating the real impact of peers influence. That is, unobservables would be positively correlated to peers measure.

[Insert Table 3 about here]

In fact, elasticity is around 55% irrespectively to the considered IV specification. In any case, our peer pressure influence is lesser than the one accounting for classmates' impact, e.g. students are easily influenced by their classmates rather than by their small group of friends.

4.3 Sample subgroups: gender, last year friends, movers and leaders

In a further step we divided the sample into subgroups based on several individual characteristics. Firstly, we perform IV estimations in equations (2) and (3) of Table 3 separating boys and girls given that the amount of body fat changes with age and gender.. Following Renna *et al.* (2008) this stratification is examined to verify whether adolescents are more or less influenced by the body weight of their same gender peers. Mirroring previous findings, our results confirm that while the IV "all nominated friends" peer effect for females is positive and highly significant, for males this influence becomes insignificant. In addition we test whether peers of the same gender are more influential in explaining adolescent weight. Equation (4) reports that female adolescent BMI is positively influenced by the BMI of her female friends peer group. Note that this impact is considerably higher that the effect estimated in equation (3).

Secondly, we accounted for those students indicating that they hold the same friends compared to the previous academic year. This result is shown in table 7, column 4. It is expected that those individuals who are connected to the same peers will be exposed to a greater influence from their peers to that displayed by those who accommodate to new friends. This is corroborated through our estimations. Thirdly, the same result is expected and corroborated for those who have not changed their residence. Fourthly and finally, whether the individual affirms he/she considers himself/herself as a leader within the clique will influence the estimated results. That is, those who consider themselves as the leader in their clique are more influential rather than easily influenced. Table 7, column 6 show that those individuals not reporting being the leader display a greater influence from their nominated friends than the one observed from the average behaviour.

4.4 Classmates influence

Then, we question whether our identifying assumption would be violated if the selection of friends is correlated with BMI (Trogdon *et al.*, 2008). Hence we follow an alternative strategy that defines peer groups at a broader level, namely assuming that all classmates constitute the reference group. This approach allows us to collapse unobservables at the classroom level. Interestingly, this coefficient is considerably high (0.84) and after

controlling by school- and neighbourhood-specific fixed effects slightly diminishes (0.80%). Comparing classmates' impact to that of the other introduced covariates throughout the empirical analysis; we observe that this is one of the greatest influent covariates on individual BMI. In accordance to Cohen-Cole and Fletcher (2008), introducing contextual controls, i.e. accounting for classroom heterogeneity, reduce biases in peers' impact. Our argument, in line to Eisenberg *et al.* (2005), is that students share classrooms during almost thirty five hours a week with more or less twenty five students. Therefore, it is really likely that although students share their leisure time and academic effort with a few specific students within their clique, they are not free of being influenced by the rest of classmates. Likewise, it is somehow odd that students allocate themselves into knit cliques with no other relationship at classroom level. Granovetter (2005) argues that smaller networks are connected to other networks by the strength of weak ties, which also occurs in classrooms. Then, information flows in a way that overlaps cliques.

Obviously, this measure is contaminated by simultaneity but, unless the individual turns out to be a high influence for all their classmates, the endogeneity problem might not be so relevant. Then, we estimated considering only those pupils who do not consider themselves as a leader, that is, those who might not be influential for their classmates. Results show that classmates influence elasticity slightly decreases from 84% to 83%. Remember that although throughout the empirical analysis we are introducing covariates accounting for contextual incidence, the endogeneity problem occurs if the peer variable measures classmates' BMI is contemporaneously.

5. Concluding remarks

TO REVISE

In this paper, we have investigated peers' influence on adolescents' BMI in Catalonia (Spain). Making use of a unique survey containing information regarding relationships occurring within classrooms, we provide evidence on the dissimilar obtained impact when choosing the peers' measure. Note that, contrary to previous literature on this issue we take advantage of using complete information regarding all nominated friends by high school students without any limit on the number of friends to be marked. Since these measures might be considered endogenous, we performed several sensitivity analyses to corroborate our finding and instrumentalized through the use of peers' parental background information.

Our results indicate that cliques' relationships are not completely symmetric and that after accounting for correlated effects and fixed effects and using instrumental variables throughout the empirical analysis, peers have an influence on individual BMI. Notwithstanding, the magnitude of this peers' exposure impact turns out to be smaller to classmates estimated incidence. We hypothesize on this that students mirror on all their classmates rather than only focussing on their specific peers through the impact of the strength of weak ties across cliques.

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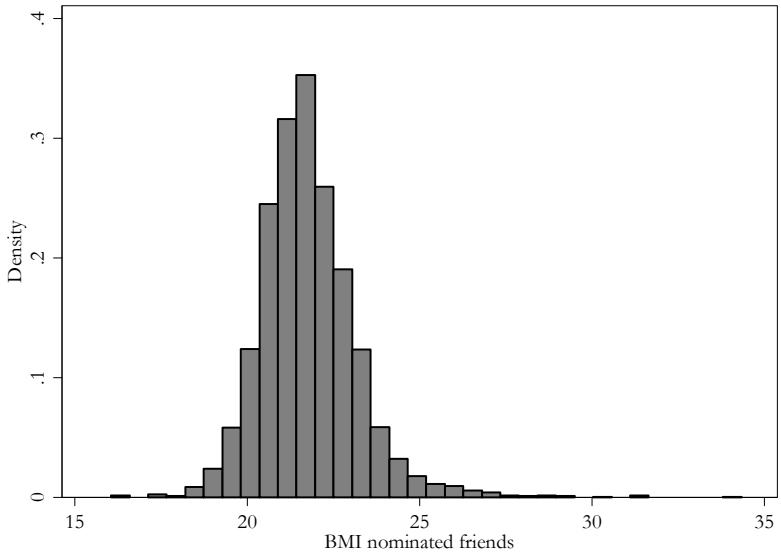
Figure 1 Distribution of average BMI among peers

a) all nominated friends



b) mutual friends

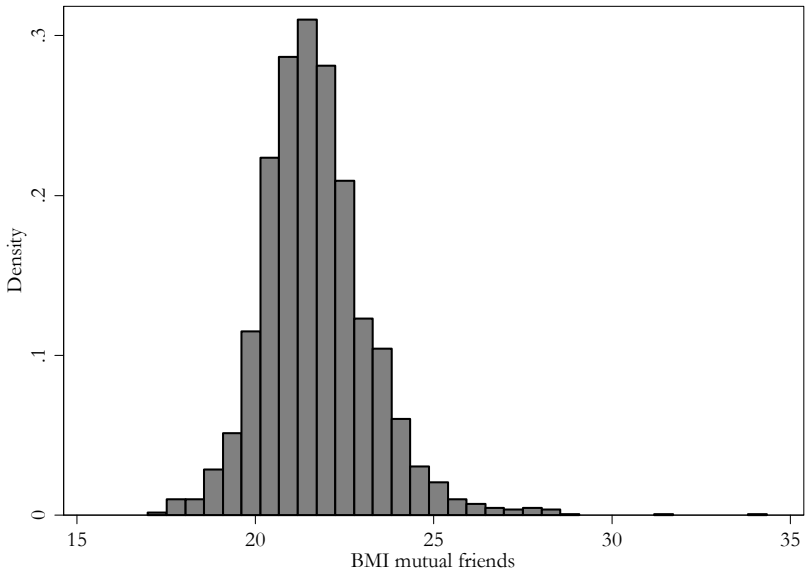
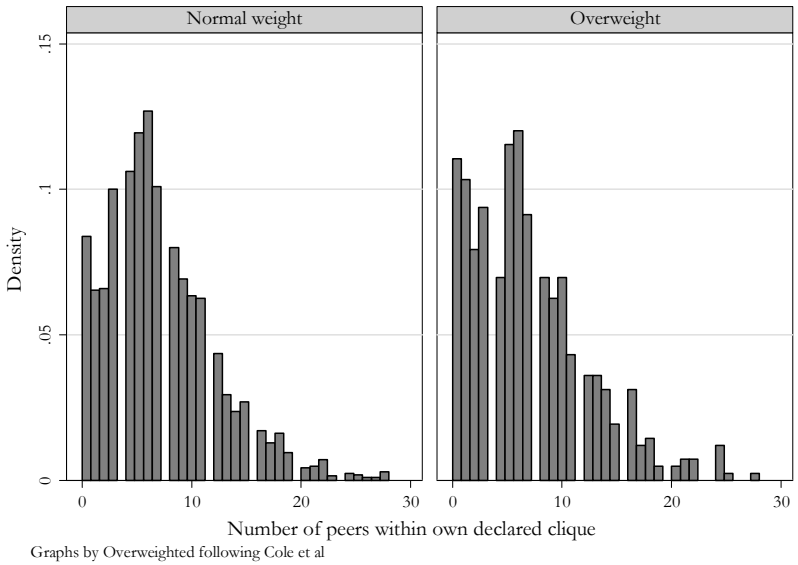


Figure 2 Distribution of nominations by BMI status

A) all nominated friends



b) mutual friends

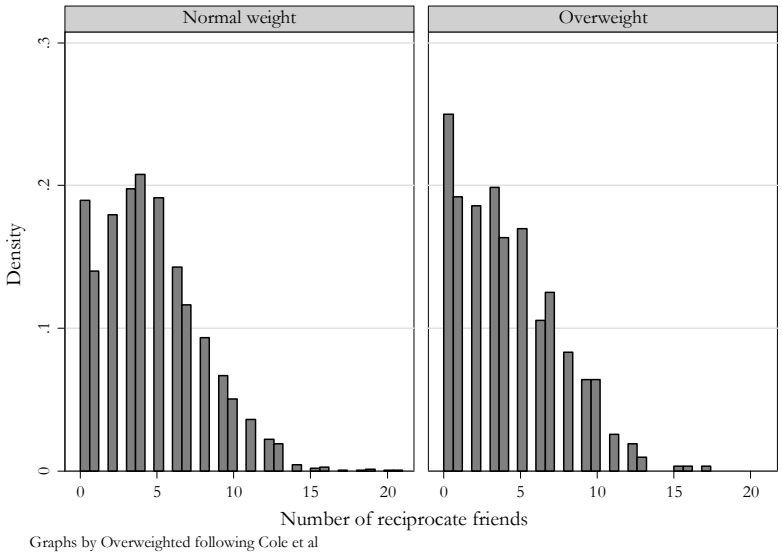


Table 1 Description of Control Variables

Variables	***Definitions***
	Adolescent controls
Age	Age in years
Female	0-1 dummy that equals 1 if female
Immigrant status	0-1 dummy that equals 1 if immigrant
Habitual smoker	0-1 dummy that equals 1 if smokes daily
Had drink over the last weekend	0-1 dummy that equals 1 if have drunk alcohol in the last weekend
Sleeping time	Number of hours slept habitually per day
Reading time	Number of weekly hours reading books, magazines, newspapers…
TV watching time	Number of daily hours watching TV
	Family controls
Monoparental families	0-1 dummy that equals 1 if parents are divorced, widowed or monoparental families
Mother attains primary education	0-1 dummy that equals 1 if adolescent's mother has primary education
Mother attains higher education	0-1 dummy that equals 1 if adolescent's mother has university education
Differential age student-mother	Difference in years between the mother and the adolescent
Mother's poor health status	0-1 dummy that equals 1 if adolescent's mother has poor health
No familiar involvement in homework	0-1 dummy that equals 1 if student does not receive any help from their parents
	Class-level controls
Share of mothers with higher education	Proportion of classroom mothers' attaining university education
Share of female classmates	Proportion of classroom female students

Table 2 OLS regressions

Individual BMI	Eqn. (1)	Eqn. (2)	Eqn. (3)	Eqn. (4)	Eqn. (5)	Eqn. (6)	Eqn. (7)	Eqn. (8)
BMI mutual nominated friends	0.105 (0.05)**	--	0.093 (0.05)*	--	0.074 (0.06)	--	--	--
BMI all nominated friends	--	0.171 (0.04)***	--	0.108 (0.04)**	--	0.091 (0.04)**	-0.017 (0.05)	-0.017 (0.05)
Consciousness factor			-0.825 (0.48)*	-0.814 (0.41)**	-0.884 (0.48)*	-0.850 (0.41)**	-0.942 (0.42)**	-0.915 (0.50)*
Student's age			0.202 (0.06)***	0.250 (0.06)***	0.215 (0.06)***	0.265 (0.06)***	0.289 (0.06)***	0.302 (0.07)***
Female			-0.758 (0.13)***	-0.822 (0.11)***	-0.754 (0.13)***	-0.815 (0.12)***	-0.822 (0.12)***	-0.870 (0.14)***
Immigrant status			0.399 (0.31)	0.299 (0.26)	0.387 (0.32)	0.288 (0.26)	0.373 (0.27)	0.424 (0.28)
Habitual smoker			-0.360 (0.16)**	-0.372 (0.15)**	-0.355 (0.16)**	-0.374 (0.15)**	-0.362 (0.16)**	-0.340 (0.17)*
Had drink over the last weekend			-0.058 (0.14)	-0.112 (0.12)	-0.061 (0.13)	-0.109 (0.12)	-0.129 (0.12)	-0.199 (0.13)
Sleeping time			-0.172 (0.06)***	-0.093 (0.05)*	-0.174 (0.06)***	-0.094 (0.05)*	-0.097 (0.06)*	-0.101 (0.06)*
Reading time			0.060 (0.03)*	0.056 (0.03)*	0.064 (0.03)*	0.060 (0.03)**	0.063 (0.03)**	0.052 (0.03)
TV watching time			0.097 (0.04)**	0.107 (0.04)***	0.084 (0.04)*	0.098 (0.04)**	0.084 (0.04)**	0.089 (0.04)**
Monoparental families			-0.259 (0.16)	-0.003 (0.14)	-0.245 (0.16)	0.007 (0.14)	0.013 (0.14)	-0.011 (0.15)
Mother attains primary education			0.469 (0.19)**	0.571 (0.15)***	0.395 (0.20)**	0.524 (0.16)***	0.465 (0.16)***	0.390 (0.19)**
Mother attaining higher education			-0.254 (0.14)*	-0.244 (0.12)*	-0.112 (0.15)	-0.127 (0.13)	-0.138 (0.14)	-0.142 (0.15)
Differential age student-mother			-0.029 (0.02)*	-0.017 (0.01)	-0.024 (0.01)	-0.014 (0.01)	-0.010 (0.01)	-0.007 (0.01)
Mothers poor health degree			0.203 (0.20)	0.201 (0.17)	0.202 (0.20)	0.195 (0.17)	0.242 (0.17)	0.179 (0.18)
No familiar involvement in homework			-0.255 (0.13)**	-0.214 (0.10)**	-0.259 (0.13)**	-0.223 (0.10)**	-0.254 (0.11)**	-0.279 (0.12)**
Share of mothers with higher education					-1.130 (0.40)***	-0.903 (0.32)***	-0.432 (0.59)	-0.795 (0.69)
Share of female classmates					0.011 (0.41)	-0.105 (0.34)	0.023 (0.44)	-0.188 (0.48)
School Fixed Effects	NO	NO	NO	NO	NO	NO	YES	YES
Neighbourhood Fixed Effects	NO	NO	NO	NO	NO	NO	NO	YES
N	2,117	2,934	1,858	2,587	1,858	2,587	2,587	2,577
R^2	0.1088	0.1425	0.1670	0.1993	0.1708	0.2016	0.2264	0.3265
F-global	79.00 (0.00)	269.44 (0.00)	16.33 (0.00)	40.57 (0.00)	15.33 (0.00)	37.63 (0.00)	19.92 (0.00)	58.78 (0.00)

Notes: Adjusted robust standard errors for clustering at the classroom level were computed and reported in brackets. ***, ** and * denote statistical significance at 1, 5 and 10% respectively. Regressions include a dummy variable for outliers and a constant term.

Table 3 IV estimations – Dividing sample

Individual BMI	**Eqn. (1) Both sexes**	**Eqn. (2) Male**	**Eqn. (3) Female**	**Eqn. (4) Female influenced by female group**	**Eqn. (5) Same friends last year**	**Eqn. (6) Not changed residence**	**Eqn. (7) Not reporting as leader**
BMI all nominated friends	0.530 (0.25)**	0.379 (0.25)	0.706 (0.28)**	0.843 (0.39)**	0.659 (0.30)**	0.506 (0.29)*	0.704 (2.70)***
Individual controls	YES	YES	YES	YES	YES	YES	YES
Family controls	YES	YES	YES	YES	YES	YES	YES
Class-level controls	YES	YES	YES	YES	YES	YES	YES
Fixed Effects (school & neighbourhood)	YES	YES	YES	YES	YES	YES	YES
N	2,587	1,250	1,337	1,337	2,024	2,237	2,364
R^2	0.1196	0.0922	0.1224	0.0542	0.0295	0.1153	0.0916
F-global	2.83 (0.00)	32.22 (0.00)	10.70 (0.00)	10.56 (0.00)	44.08 (0.00)	49.37 (0.00)	23.37 (0.00)
F Kleibergen-Paap identification	20.31	11.70	7.44	7.95	15.15	14.07	35.11
Under identification	40.89 (0.00)	32.41 (0.00)	31.75 (0.00)	17.66 (0.00)	30.99 (0.00)	29.00 (0.00)	17.36 (0.00)
Hansen J	2.17 (0.14)	0.86 (0.65)	7.42 (0.06)	1.19 (0.27)	3.48 (0.06)	2.55 (0.11)	1.96 (0.16)

Notes: Adjusted robust standard errors for clustering at the classroom level were computed and reported in brackets. Then, ***, ** and * denote statistical significance at 1, 5 and 10% respectively. Regressions include a dummy variable for outliers and a constant term.