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# The relationship between obesity and tertiary education outcomes: a systematic review

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## ABSTRACT

Previous reviews have documented an overall weak or uncertain association between obesity and school-based educational attainment in children and young people. However, up to half of young adults will go on to further college or university education by age 30. The study aim was to systematically review evidence on the association between obesity and tertiary education outcomes in young men and women. A search of multiple databases including Embase, Global Health, ERIC, Medline, PsycInfo, and Science Citation Index was conducted in March 2018. Cross-sectional and longitudinal studies were included that reported on young people aged 16+, an association between obesity and academic achievement, and a comparison to healthy weight students. Risk of bias was assessed using criteria from the STROBE checklist. From 1297 records, 16 studies met all inclusion criteria. All six cross-sectional studies and 8/10 longitudinal studies reported lower educational achievement by students with obesity. All longitudinal studies were at low risk of bias but four cross-sectional studies were at medium risk and two at high risk of bias. Three of four studies showed reduced enrolment, in 6/8 graduation was less likely, and all 6 studies reporting on performance showed this was lower in those with obesity. Five of nine studies reported that obesity had a greater impact on educational achievement for women. Overall, there is compelling evidence of weight bias in that students with obesity do less well in tertiary education than their healthy weight peers. It is likely that university/college attainment is less impacted by socio-economic factors than school-based achievement. A better understanding of the processes that underpin this weight bias is needed, including stakeholder (student, staff) experiences of weight stigma, perceived or enacted. Responsive actions could

mirror those to address disability or gender bias, or in health promotion in tertiary education settings.

# INTRODUCTION

Characterizations of the impact of weight stigma include education as a domain in which people with obesity are disadvantaged.[1] While this may not be as evident as in the workplace, negativity can be seen in some teaching staff attitudes and expectations.[2] For example, teachers' perceptions of the academic ability of overweight children at school may be reduced, regardless of the children's objectively measured performance in reading and maths.[3,4] The potential for an accumulation of negative experiences over the course of school raises the question of whether children with obesity have poorer educational outcomes than their healthy weight peers. That is, whether there is evidence of weight bias in terms of educational achievement.

The review by Taras and Potts-Datema was the first to consider the relationship between obesity and student performance at school.[5] It was one of several reviews by these authors published around the same time that considered the impact of common chronic childhood health conditions on educational outcomes. All nine of the studies included demonstrated poorer achievement in children who were overweight or with obesity. More recent systematic reviews have reached rather different conclusions as the evidence base has expanded. For example, Caird et al identified 29 studies published up to 2009 and determined that there was an overall weak association between obesity and educational attainment in children and young people.[6] This became even weaker when variables such as family socio-economic status and other measures of deprivation were taken into account. In around half of the studies these factors accounted for the association between obesity and educational achievement better than obesity itself.

Further reviews have reached a similar outcome. One concluded there was an "uncertain association" based on strength of evidence, study quality, and moderation by other variables.[7] Restricting their inclusion to longitudinal studies, another found no evidence of an association in pre-adolescents or across most areas of academic achievement in adolescents.[8] There was some indication of poorer maths scores in young adolescent girls with obesity, but this was the exception within a raft of non-differences.

Common to all these reviews has been a focus on school-based achievement and the intentional exclusion of students in tertiary or university education. Yet this excludes a key phase in young people's educational experience. It should be noted that tertiary education refers to post-school study at college and university, and therefore degree and vocational qualifications. However, the greater focus is on higher level qualification such as diploma, bachelor's, and master's degrees. Accordingly, in their global report on education the OECD (Organisation for Economic Co-operation and Development) observed that some three quarters of young people in Australia, 55% of those in the US, and nearly half of young people in the UK are expected to graduate from tertiary education before the age of 30.[9] Proportionately more women currently graduate than men. Those from disadvantaged backgrounds are less likely to be in tertiary education, a disadvantage that is likely to continue in countries such as England where they and their families bear the cost of continued education in tuition fees and living costs.[10] Higher education is a bridge to employment for most students. Across the world,

those with a tertiary degree are 10% more likely to be employed and will earn over 50% more than adults who have only completed secondary education.[9]

The aim of the present study was to conduct a systematic review and provide a narrative synthesis on the association between obesity and tertiary education outcomes in young men and women. Specifically - do young people with obesity underperform in tertiary education? Are they less likely than healthy weight peers to gain admission to college/university, more likely to score lower in their academic work, or more likely to fail to complete tertiary education courses?

## METHODS

The protocol for the systematic review was developed and published on PROSPERO (CRD42018091858). We adhered to PRISMA guidelines in the reporting of the review.

### Types of studies

A PICO framework was agreed. Accordingly, the inclusion criteria were: (1) reported on young people aged 16+; (2) an assessment of tertiary (post-secondary school/college/university) educational achievement (course entry/acceptance, grades awarded or other measure of performance, and/or course completion); (3) a measure of obesity (typically BMI ≥ 30 kg/m$^2$) based on body weight measured or self-reported before or at the time of the assessment of tertiary educational achievement; (4) a reported association between obesity and academic achievement, and (5) comparison with the academic achievement of healthy weight

students. We included cross-sectional and longitudinal studies in this review. Review articles were excluded.

Search strategy

*Electronic searches*. In March 2018, we searched from inception the Cochrane Database of Systematic Reviews (CDSR; Willey), CENTRAL (Willey), Embase (Ovid), ERIC (Education Resource Information Centre), Global Health (Ovid), Medline (Ovid), Medline in Process (Ovid), Medline Epub Ahead of Print (Ovid), Dissertations & Theses (ProQuest), PsycInfo (Ovid), Science Citation Index (SCI) (Web of Science), Social Science Citation Index (SSCI) (Web of Science), SCI Conference Proceedings (Web of Science) and SSCI Conference Proceedings (Web of Science). Searches were developed for the concepts: obesity, academic achievement, and young adults. Subject headings and free text words were identified for use in the search concepts by the information specialist and project team members. Further terms were identified and tested from known relevant papers. The search was peer-reviewed by a second information specialist and the search strategies are available in the supplementary Table. No date or language limits were applied to the searches. The results of the database searches were stored and de-duplicated in an EndNote library. Paper references were examined for other potential studies that met the review inclusion criteria. The titles and abstracts of all identified studies were screened independently for inclusion by two reviewers (AJH and IDC). Any discrepancies were resolved by discussion.

Data extraction

A copy of the full text was obtained for all studies meeting the screening criteria. A data extraction form was developed and each paper was coded and reviewed independently by two reviewers (AJH and IDC). Again, any discrepancies in coding were resolved by discussion. The following information was extracted: (a) year of study, (b) participant sample and size, (c) study design, (d) mean age at obesity assessment, (e) mean age at education assessment, (f) country, (g) measure of educational achievement, (h) main findings, (i) gender difference, and (j) covariates used in the analysis. We summarised the main study findings as reported by paper authors, focusing on differences in educational achievement between students with obesity and those of healthy weight. If authors included covariates in the analyses these were noted in the summary Table and the findings reported after adjusted analyses. We also recorded whether gender differences in educational achievement were tested for. Study and sample characteristics and assessments of educational achievement varied substantially. Therefore no meta-analysis was performed.

Risk of bias

Risk of bias was assessed using the criteria described by Santana et al,[7] themselves based on the STROBE statement checklist. A score of zero (absent or inadequately described) or one (present and explicitly described) was assigned to the following questions:

(1) Did the study describe the eligibility criteria for participant selection?

(2) Were participants randomly chosen from the population?

(3) Did the study report the sources and details of the method for measuring academic performance and did the measurement have acceptable reliability?

(4) Did the study report the sources and details of the assessment methods for measuring obesity and did the instrument have acceptable reliability?
(5) Did the study use a statistical method that was adequate to test the hypothesis?
(6) Did the study report the number of participants for each outcome measurement and did this number represent at least 80% of the total sample?

A score for each article ranged from zero to six points. Studies with ≤ 2 were considered high risk of bias, studies that achieved three to four points were classified as medium risk, and those that had scores of five to six were classified as low risk of bias.

## RESULTS

### Results of search

The database searches identified 1943 records with 1297 remaining once duplicates were removed (Figure 1). After title and abstract screening, 43 full papers were considered for inclusion, and 16 studies met the inclusion criteria and were retained in the review.

- Figure 1 near here -

### Characteristics of included studies

The main characteristics and findings of the 16 studies are summarised in Table 1. Six studies were cross-sectional and ten were longitudinal in design. Most were conducted in the USA (N=13), with one each in Pakistan, Sweden, and the UK. Studies reported on university academic performance, or university or college enrolment, and/or degree attainment (graduation). It was not possible to distinguish university from college achievement.

- Table 1 near here -

Participants

The study sample sizes ranged from 77 to 752,283. One study reported on an all-female sample[11] and the one with the largest sample size on an all-male military conscript sample.[23] The ten longitudinal studies drew from a limited evidence base as five reported on data from the National Longitudinal Survey of Youth (NLSY)[12,13,16,21,25] and three from the National Longitudinal Study of Adolescent to Adult Health (or Add Health).[17,20,22] Some of these papers reported on different selections from the same survey waves and others from different survey waves.

Risk of bias

All the longitudinal studies were classified as at low risk of bias. In contrast, four of the cross-sectional studies were classified as medium risk[14,15,18,26] and two as high risk of bias.[11,19] Self-reported weight (and height) was the most commonly failed criterion (reliability of obesity assessment) and applied to most of the cross-sectional studies[11,14,15,18,19] and all those using NLSY data.[12,13,16,21,25] Five studies failed to describe the eligibility criteria for participant selection,[11,14,18,19,26] four did not state whether participants were randomly chosen from the population,[11,14,19,26] three failed to adequately report the reliability of the measure of academic achievement,[15,18,19] and one did not have a robust statistical approach.[11] In addition, all of the longitudinal studies, but none of the cross-sectional studies, included statistical controls in their analysis for factors that might affect the relationship between obesity and academic achievement. Most often these were parental earnings and education or an alternative measure of socio-economic status, age, and ethnic background.

Main findings

Overall, 6/6 cross-sectional studies and 8/10 longitudinal studies reported evidence of lower educational achievement by students with obesity at university in comparison with healthy weight students. The two exceptions were published in the 1990s and had a primary focus on employment. Both noted that people with obesity had completed significantly fewer years of school prior to university[24] or fewer years of education (school plus university),[25] even though there were no differences in the proportions of healthy weight or those with obesity who completed university (just under 20%).

All of the cross-sectional studies used course level performance such as grade point average (GPA) as their measure of educational achievement. Adding the one longitudinal study that reported on highest degree awarded,[16] all 6 of the studies reporting on *performance* found this was lower in those with obesity. Regarding university *completion* (award of a degree), six of the eight found this was less likely in those with obesity. Only four studies reported an assessment of university *enrolment*. Three found this was less likely in those with obesity.[12,22,23] The exception was an analysis of waves I-V of Add Health in which university enrolment was unaffected, as was graduate school enrolment (i.e. take up of post-graduate study), but degree completion was less likely in those with obesity.[17] Crosnoe also reported an analysis of waves I-III of the same cohort but found a difference in enrolment.[22] However, this was not a 'pure' measure of enrolment as it combined those currently attending university with those who had already graduated.

The age at which obesity was assessed varied from 13-14 years to young people in their early twenties. The longitudinal studies determined obesity status at a younger age than the cross-sectional studies. However, the lack of variation in educational achievement outcomes prevented any comparison by age at which obesity was assessed. Two studies related trajectory of obesity during adolescence to educational achievement, noting an impairment in achievement in those with obesity early and later in adolescence, and in those whose obesity developed during adolescence.[12,20]

Possible gender differences were investigated in nine studies. Five reported that obesity had a greater impact on educational achievement for women[12,13,16,17,22] while four failed to find a gender difference.[14,15,24,25] All of those finding a gender difference were longitudinal studies (low risk of bias) while two of those failing to find a difference were cross-sectional studies (both medium risk of bias). Of the three studies reporting a gender difference in the analysis of the NLSY97 cohort, one, the report by Cheng, noted that it was only females in the late teen obesity onset group who did worse than males in terms of university completion.[12]

## DISCUSSION

The studies in this review offer compelling evidence that students with obesity do less well in tertiary, primarily university/college, education than their healthy weight peers i.e. that there is weight bias in this setting. The clearest and most reliable evidence was on completion (award of a degree). There were much less data on likelihood of enrolment. Only two studies reported on both in the same samples. Karnehed et al found a relationship between obesity and both measures of

achievement in their sample of Swedish male conscripts.[23] This was not the case for the analysis of Add Health in the USA; there was no effect on enrolment but a reduced likelihood of completion by students with obesity.[17]

The clarity of these findings in university/college settings contrasts with the weak or uncertain association between obesity and student achievement in primary or secondary (high) school.[6-8] The evidence base is limited in comparison with that of school students, in the number of studies conducted, and the available measures of achievement. However, it does represent performance by a select group of young people, those who choose to continue their education, some of them away from home, with a strong expectation of future employment.

The findings are consistent with a reduced expectation of further education achievement observed in some young people with obesity. Studies of high school seniors in the USA[27] and Australian women aged 18-23[28] reveal a lower expectation of graduating from university and lower aspiration to additional qualifications, respectively, in young people with obesity. The Australian women did not differ from those of healthy weight in their future hopes for employment, relationships, or children, only for further educational qualification.

Most important however is the likely role of disadvantage in determining the difference in the association that obesity has with achievement in university compared to earlier education. For example, children and young people in England from low socio-economic backgrounds under-perform in comparison with their more advantaged peers. By the end of primary school the gap in achievement is 9.5

months, increasing to 19.3 months around the age of 16.[29] By mid-adolescence therefore, disadvantaged students are more than a year and a half behind in their educational attainment. For those with persistent disadvantage (indicated by being consistently in receipt of free school meals), they are 24.3 months behind. It is unlikely that a state of body such as obesity will contribute further to this gap, especially since vulnerability to overweight is entwined with the factors that define social inequality.

Inequality in educational attainment is similar in Australia but with additional factors to recognise. By age 15, those from low income families are 2.5 years behind high income families in educational achievement.[30] Living in a remote area (*vs* metropolitan) is associated with a 2 year gap in maths and literacy, and being an indigenous young Australian, a 2.5 year gap. University attainment once in study is less impacted by socio-economic factors as they, and educational qualifications, determine access. Young people from disadvantaged backgrounds are under-represented in the university student population in countries such as England that currently have high tuition fees.[31] In 2017, 14% of 18 year olds from the most disadvantaged areas entered university education, in comparison with 53% of those from the most advantaged areas.[32] The latter were therefore 3.8 times more likely to enter university education than those from the most disadvantaged areas. It is reasonable to assume that these patterns will be mirrored in university and college education across the developed world. Accordingly, with university educational attainment less affected by socio-economic disadvantage then there is relatively more opportunity to detect the influence of individual characteristics such as obesity.

Finance has been raised as an issue in the literature reviewed. With university in Sweden being free it has been argued that parental ability to pay should not have affected university enrolment in the all-male conscript cohort.[23] This contrasts with an observation some 10 years earlier that young women with obesity were less likely than their healthy weight peers to receive parental financial support for university education in America, another country with tuition fees, and therefore less likely to enrol.[33] But fees are not the only financial demands on students. Living costs and the opportunity costs of not being in employment additionally disadvantage those from less affluent backgrounds.

The review evidence suggests that once at university, women with obesity were more affected than men in their educational achievement. Two of the studies used some of the information on psychosocial characteristics available in the Add Health and NLSY cohorts to reveal potential mechanisms. Crosnoe reported that around a third of the lower odds of university/college enrolment in girls with obesity was accounted for by factors such as self-rejection, suicidal ideation, and truancy.[22] Cheng observed that conscientiousness (being a dependable person) was a personality trait that moderated some of the relationship between obesity and likelihood of university/college completion.[12] Exploiting assessments of psychological and social variables collected in longitudinal cohorts adds value to these analyses. However, moderation analysis is constrained by the information available, a limitation of secondary analyses.

By including measures of aptitude or IQ and therefore accounting for possible differences in ability, other studies have pointed to interpersonal or education context

reasons for differences in achievement.[18,23] Peer victimization[34] and reduced attention or negative expectations of teachers[35] are possible expressions of these. But as has been acknowledged, aptitude and IQ tests may not adequately capture the skills important to high level academic success. There are other indirect mechanisms that may have a role but are not assessed such as poor physical or psychological health, both of which may undermine confidence, reduce effort, and/or result in absenteeism. Since attendance is not monitored as closely at university as it is at school then there is no information on absenteeism in the context of obesity in tertiary education. In contrast, absenteeism in the workplace is evident; adults with obesity are more likely to have longer-term (but not shorter-term) sick leave.[35] There is clearly opportunity for primary research on this topic.

Longitudinal studies offer the potential to say something about the direction of causal association and authors have distinguished 'selection' and 'causation' processes. Selection processes suggest that obesity confers disadvantage to entering higher education (or slimness a relative advantage). In contrast, causation processes suggest that advanced education helps to restrain any increase in BMI or obesity onset in the future. In their analysis of NLSY97, looking at the relationship between weight status at age 17 and the highest degree attained by age 29, von Hippel & Lynch concluded that around three quarters of the educational gradient in BMI was due to selection, the other quarter due to causation.[16] Note that this analysis was by BMI and that caution is needed in what is concluded about obesity which is at one extreme of the BMI distribution. By way of contrast, there is an extensive literature supportive of causation processes, that relates attainment of a university/college educational qualification to lower prevalence of obesity later in life (in high income

countries at least).[36] Note that the time between the educational qualification and assessment of obesity prevalence is generally large and much greater than that in the studies included in the present review.

There are a number of limitations to our review conclusions. There was a small number of publications and narrow range of academic achievements relative to the school-based literature. There is the possibility of selective reporting and publication bias in this literature. For example, tertiary education providers as private establishments may be less motivated to reveal influences on educational outcomes than the state-funded primary and secondary education providers. A narrative rather than statistical synthesis was considered as most appropriate to this evidence. Furthermore, two American surveys (three cohorts) dominated the longitudinal literature reviewed. There was general consistency in findings but some exceptions (e.g. in the reports of Amis et al and Crosnoe[17,22]). There were also differences between the findings from the NLSY cohorts of 1979 and 1997.[21] Again, it is important to stress that none of the longitudinal and few of the cohort studies were designed to test the relationship between obesity and academic achievement. In addition, tertiary education is more than degree level education at university or college. Accordingly, we know little about what having obesity may have non-degree level or vocational training outcomes.

Most studies exploited the data available and, as secondary analyses, were constrained by the cohorts themselves and the way the key measures were determined. This limitation is shared by the literature on educational achievement at secondary school and younger.[6] Perhaps most importantly, the studies in this review

mostly speak to a particular place and time in the lives of college/university students. Those in the longitudinal cohorts engaged with university education between 15 and 35 years ago. Generalization to today's young people and educational circumstance is somewhat questionable. Not only has the prevalence of obesity increased, much has changed in terms of access to post-school education and it's financing. There are even greater differences in the delivery of university education and the interface with employment expectations and opportunities.

In terms of future research priorities, university completion is a very blunt measure of academic achievement. All students who graduate do so with detailed records of academic achievement. These are also available for those who terminate their course prior to graduation. There is the opportunity for a much more nuanced understanding of the relationship between obesity and tertiary academic achievement if we are able to link primary care health data on weight (collected pre-university/college or at registration) to academic transcripts. This could also indicate whether obesity affects motivation and ability to enrol on courses differently, the quality of assessed and examined work while at university/college, progression across the years of study, and course completion. These are distinct parts of the tertiary education process. Secondly, qualitative research with stakeholders, students and staff should be conducted, as it has been for younger students.[6,8] It is important that the experiences of university students with obesity, past and present, are listened to. This may help us better understand the mechanisms that underpin any educational disadvantage in relation to obesity.

In conclusion, the first published research on the association between obesity and tertiary education was prompted by a "casual observation" that obesity was less prevalent in 1960s prestige American colleges than public high schools.[26] The prevalence of obesity has increased dramatically since then, as has young people's access to tertiary education. Students currently attending university have a different experience from those in the primary and secondary school cohorts reviewed above. Critically, students attending university are less likely to come from disadvantaged backgrounds. This may underpin why obesity can be detected affecting university educational attainment but less so in earlier education.

We know relatively little about the processes that underpin this apparent weight bias: why people with obesity appear to do less well within university settings, the extent of this detriment in terms of academic award, and why this may be experienced more by young women than men. Stigma, perceived or enacted, consciously or unconsciously, is a strong candidate[1] but there may be other less obvious explanations. In terms of action against weight bias then clearer evidence of prejudice and discrimination in these settings is needed. If the experiences of student and staff confirm weight-related discrimination then this will inform the response. For example, there could be consideration whether actions similar to those to address gender and disability equality in tertiary education would be effective in ameliorating weight bias. Alternatively, whether weight bias could be moderated through the charter for health promoting universities and colleges.[38] This combines actions to lead health promotion with those that, "embed health into all aspects of campus culture, across the administration, operations and academic mandates."

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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**Figure 1.** PRISMA diagram of study selection process

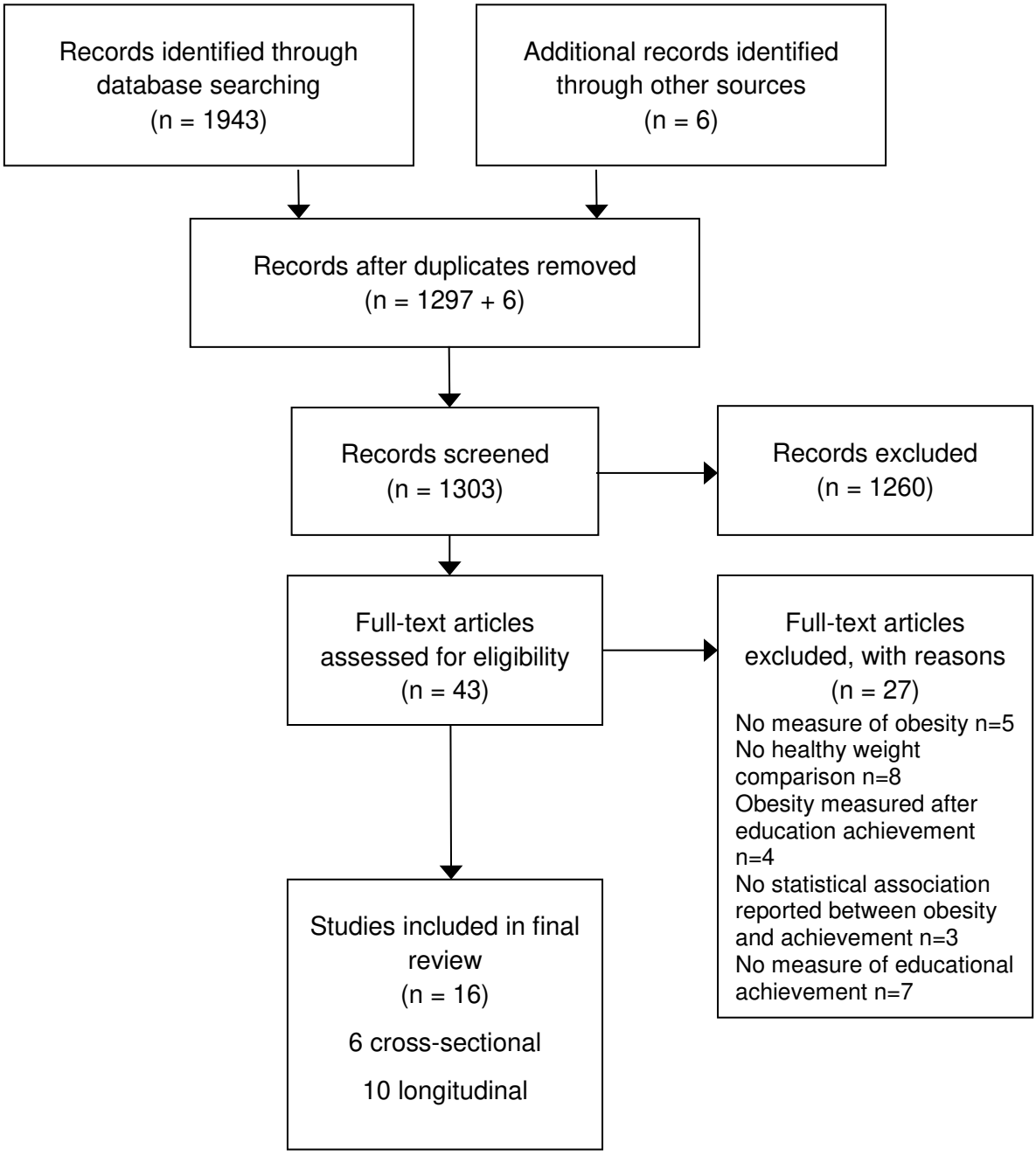

Table 1. Characteristics of included studies

| Study | Participants | Design | Mean age at obesity assessment | Mean age at education assessment | Country | Measure of educational achievement | Main findings | Gender difference | Covariates | Risk of bias |
|---|---|---|---|---|---|---|---|---|---|---|
| **Suraya et al 2017[11]** | Female medical students (single university) N=191 | Cross-sectional | 21.3 | 21.3 | Pakistan | GPA[1] | GPA score lower in those with obesity (BMI>35) | NA (all female sample) | None | High |
| **Cheng 2017[12]** | NLSY97 selected by age N=2275 | Longitudinal | 13-14 | 25-27 | USA | University enrolment<br><br>University completion[2] | 0.50 (0.36, 0.69) odds of enrolment and 3.49 (2.10, 5.81) odds of dropout by those with chronic obesity. 0.61 (0.43, 0.87) odds of enrolment and 1.86 (1.07, 3.22) odds of dropout in those with late teen onset obesity | Yes, but only females in the late teen onset group | Noted that those with obesity were more likely from minority ethnic background, low maternal education, not from 2 biological parent family | Low |
| **Benson et al 2017[13]** | NLSY97 selected by age N=2315<br><br>(overweight combined with those with obesity) | Longitudinal | 17-18 (range 14-22) | 47-48 | USA | University completion | 57% (.24, .76) lower odds of women with overweight graduating, no difference for men | Yes, greater impact on women | Other significant predictors included: minority ethnic background, parental education | Low |
| **Anderson & Good 2017[14]** | University students (single university) N=279 | Cross-sectional | 21.3 | 21.3 | USA | Semester final grade | Semester grade lower in those with overweight or obesity | No | None | Medium |

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| **Odlaug et al 2015[15]** | University students (single university) N=1765 | Cross-sectional | 22.6 | 22.6 | USA | GPA | GPA score significantly lower in those with obesity (p=0.01) | No | None | Medium |
| **von Hippel & Lynch 2014[16]** | NLSY97 N=8665 | Longitudinal | 17 | Up to 29 | USA | Highest degree awarded | Graduation 31% less likely in males with obesity, 60% less likely in females with obesity | Yes, greater impact on women | The influence of multiple family background and social-psychological variables investigated | Low |
| **Amis et al 2014[17]** | Add Health waves I-IV N=11308 | Longitudinal | 16 | 29 (range 25-31) | USA | Attended University<br><br>University completion<br><br>Attended graduate school | None<br><br>Completion 9% less likely in those with obesity<br><br>None | Yes, 14% less likely if with obesity, female & white (9% less if with obesity, male and white) | Multiple family background variables | Low |
| **McCann & Roberts 2013[18]** | University and community college students from 24 institutions N=1036 | Cross-sectional | Mainly 18-25 | 18-25 | USA | GPA previous semester | GPA score significantly lower in those with obesity (Cohen's d=0.31) | Adjusted for in analysis | Covariates: ability, personality, well-being, sex, age, ethnicity | Medium |

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| **Franz & Feresu 2013[19]** | University students (single university) N=77 | Cross-sectional | 21.7 | 21.7 | USA | GPA | GPA score lower in those with overweight or obesity ($p<0.01$) | Not reported | None | High |
| **Chung et al 2011[20]** | Add Health waves II & IV N=6984 | Longitudinal | 16-17 (range 12-21) | Range 24-32 | USA | University completion | Graduation lower in those staying with obesity (odds ratio 0.4), and lower in those developing obesity during adolescence (odds ratio 0.6) | Adjusted for in analysis | Covariates: age, sex, parental education, race | Low |
| **Fowler-Brown et al 2010[21]** | NLSY79 N=3634<br><br>NLSY97 N=4793 | Longitudinal | 17.1<br><br>15.2 | 25<br><br>23 | USA | University completion<br><br>University completion | No difference<br><br>Graduation 39% less likely in those with obesity | Adjusted for in analysis | Covariates: age, sex, parental education, race | Low |
| **Crosnoe 2007[22]** | Add Health waves I-III N=8920 | Longitudinal | 14-15 (range 12-18) | 21-22 (range 19-25) | USA | University enrolment[3] | No difference for males with obesity, enrolment 50% less likely in females with obesity | Yes, greater impact on women | Covariates grouped: demographic, school, adolescent, social | Low |
| **Karnehed et al 2006[23]** | Male compulsory military conscripts N=752283 | Longitudinal | At conscription (18 or older) | Up to age 49 | Sweden | University completion[4]<br><br>University enrolment[5] | Those with obesity 52% less likely to complete University<br><br>And 37% less likely to start University | NA (all male sample) | Covariates: age, IQ test score, height, parental & SE variables | Low |

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| **Sargent & Blanchflower 1994**[24] | NCDS N=12537 | Longitudinal | 16 | 23 | UK | University completion | None | No | Covariates: household income, parental education, IQ, health condition | Low |
| **Gortmaker et al 1993**[25] | NLSY79 N=10039 | Longitudinal | 18 (range 16-24) | 25 (range 23-31) | USA | University completion | None | No | Covariates: household income, parental education, IQ, health condition, age, ethnicity | Low |
| **Canning & Mayer 1966**[26] | University students (2 Universities) N=1341 | Cross-sectional | Not reported, likely 18-19 | 18-19 | USA | College enrolment | No difference for males with obesity, enrolment 39% less likely in females with obesity | Yes, greater impact on women | None but noted no difference in father's education or occupation | Medium |

[1]Grade Point Average (GPA)
[2]University completion equates to graduating from college/University
[3]This measure of University enrolment combined those currently attending and who had already graduated
[4]This is measured by completion of at least 15 years of education (the minimum requirement for a university degree in Sweden)
[5]This is at least 13 years of education (corresponding to at least 1 year of university education)