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Determinants of Weight Gain in Young Women: A Review of the Literature

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Abstract

Background: Young adult women (18–36 years) are gaining weight at rates higher than women in other age groups. Given its long-term deleterious health effects, it is important to know the determinants of this weight gain. However, other than in relation to pregnancy, little is known about the determinants of weight gain in this population group.
Materials and Methods: Papers examining nonpregnancy weight gain in young women were identified through a literature search in PubMed in August 2008. Subsequently, reference lists of included papers were checked for additional eligible papers.
Results: A total of 29 papers were included in this review. They were grouped into five categories on the basis of the main identified determinants of weight gain: contraception (4); dietary behaviors (3); quitting smoking (1); physical activity (PA) (1); and university transition (20 papers). Study duration ranged from 13 days to 15 years. Weight was objectively measured in 25 studies and self-reported in 4 studies. Twenty-seven papers reported weight gain; the highest rates were observed with initial exposure to contraceptive use and the first semester of attending a university.
Conclusions: Even though young adulthood is a vulnerable time for weight gain in women, the number of studies examining specific determinants of weight gain was small. Those located identified five social and behavioral determinants, with most of the research focusing on the transition to and through a university, and few studies in nonuniversity populations. More studies are needed to assess the concurrent contributions of multiple determinants of weight gain at this life stage, so that appropriate interventions to prevent excess weight gain can be developed.

Introduction

As is widely known, overweight and obesity are at record-high levels worldwide, and in most Western developed countries the prevalence of this problem is highest among people in their fifties and sixties.[1] In Australia, however, the prevalence of overweight and obesity in young adult women has also increased markedly in recent years. Between 1995 and 2005, rates increased from 16.1% to 24.8% in 18- to 24-year-olds, and from 25.7% to 35.4% in 25- to 34-year-olds.[2] The Australian Longitudinal Study on Women's Health (ALSWH) has reported that women in their twenties gained weight at an average rate of 1.4lb/yr (from ages 18 to 23 in 1996, and from ages 28 to 33 in 2006).[3] This rate of weight gain was 30% greater than that seen in women in their forties and fifties in the same study.[3] Similar trends have been reported for young women in Europe.[4,5]

If these weight gain trends in young women continue, the problem of overweight and obesity and its associations with health problems will increase even more.[6] The resulting increases in overweight and obesity may be accompanied by increases in risk factors for many serious chronic health problems, including metabolic syndrome, diabetes, and cardiovascular disease.[7] Even before they reach mid-age, young adult women may also experience additional risks to their reproductive health; overweight and obesity have been linked to infertility,[8] reduced fecundity,[9] and pregnancy complications, such as pre-eclampsia,[10] gestational diabetes,[11] and macrosomia.[12] Maternal obesity is also thought to be a precursor for childhood obesity.[13] Therefore, in addition to the detrimental effects of weight gain for young women themselves, weight gain at this life stage can also have important health implications for their offspring. Apart from their effects on well-being, these chronic health problems will have

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significant economic impact, with increased costs of medical services for governments and the women themselves.[6]

Since pregnancy and the postpartum period have been reviewed as determinants of weight gain,[14,15] pregnancy-related weight gain was not the topic for this review. The focus was instead on the other potential underlying causes of weight gain in young women, which are not well understood. Although it is generally agreed that there is a fundamental energy balance problem,[16] to our knowledge there have been no reviews of the factors contributing to weight gain specifically in young adult women. The aim of this paper was therefore to review the literature addressing the non-pregnancy-related determinants of weight gain in young women.

Materials and Methods

Identification and selection of the literature

A literature search was carried out in PubMed (1966 through August 2008), using medical subject headings (MeSH) and free terms. An overview of the search process is shown in Figure 1. The search was conducted in two stages: (1) a PubMed search; and (2) a search for potential papers from the references of papers identified in stage 1.

Inclusion and exclusion criteria

Full text prospective observational studies that were written in English and addressed weight change in young women were included. The following inclusion criteria for age were used: (1) *average* baseline age for participants of 18 to 36 years; and (2) upper limit for the baseline age *range* of 44 years (this is the upper limit from the definition of "adult" used in PubMed's MeSH dictionary).

Studies with mixed sex or age samples were included only if results for young adult women were presented separately. Studies of clinical populations and weight loss programs or surgery were excluded.

Results

A summary of the search process is shown in Figure 1. Almost 2,500 papers were initially identified in stage 1. More than half were ineligible since they focused on treatment studies with clinical populations. The most common additional reasons for exclusion were that participants were outside the defined age range (the majority focused on children/adolescents or middle-aged adults), or the studies reported on evaluations of weight loss strategies. Only 24 papers met the inclusion criteria for this review. There was no overlap between the review papers identified in stage 1 and this review, since those reviews focused on weight gain in clinical populations or on weight loss strategies, or the participants were outside the defined age range for this review. In stage 2, another 13 potential studies were identified, 5 of which were retained. Therefore 29 studies were included in this review (see Fig. 1).

The retrieved papers were sorted into one of four categories based on the behavioral determinant of weight gain addressed: contraception,[17–20] dietary behaviors,[21–23] quitting smoking,[24] or physical activity (PA).[25] Nine papers were allocated to one of these categories. The remaining 20 papers focused on university populations.[26–45] Many of these papers did not provide a reason for weight gain other than "university attendance"; others suggested multiple concurrent reasons for weight gain and could not be allocated to one of the four behavioral categories. These papers were, therefore, placed in a category of their own. As some of these "university" papers included information about diet and PA, they were also included in the descriptive sections for these two behavioral determinants.

Contraception

Four of the 29 selected studies examined contraceptive use and weight gain, and of these, 3 reported weight gain. Details of the studies are shown in Table 1. Two assessed oral contraceptive (OC) use only, one assessed the effects of depot medroxyprogesterone acetate (DMPA) injection only, and one study compared different forms of contraceptives (DMPA and the intra-uterine device [IUD]).

Neither of the two OC studies[18,20] found significant changes in weight with OC use. Rosenberg[18] found that over 4 cycles, 52% of the participants had no weight change (defined as <2 lb change), and 28% gained more than 2 lb. Lech and Ostrowska[20] also found no significant change in body mass index (BMI) after 6 cycles of OC use.

The DMPA study reported modest weight gain.[19] This study, carried out on behalf of the World Health Organization (1986) with 1,216 women, found an average increase in weight of 0.8 lb after 3 months of DMPA use, equivalent to 3.3 lb/yr.[19] However, only 14 women discontinued its use for this reason.

The comparison study of DMPA and IUD use (103 women in each group) confirmed these results.[17] During the 5 years of the study, DMPA users gained significantly more weight (9.5 lb) than IUD users (4 lb). However, the study did not control for PA, parity, smoking, or other behavioral factors that may have been associated with weight gain.[17]

Dietary behaviors

Three U.S. longitudinal observational studies examined the role of eating or dietary behavior on weight change.[21–23] See Table 2 for details of these studies. Two of the three studies examined self-reported fast-food consumption[22,23] and found that it was associated with weight gain. In one study, for example, weight gain in those who ate one fast-food meal per week was 1.6 lb above the average weight gain over a period of three years.[23] The Coronary Artery Development in Young Adults (CARDIA) study,[22] which assessed dietary habits in 1,580 women, aged 18 to 30 at baseline, found that change in fast-food habits over 15 years was independently associated with changes in weight. Frequent fast-food intake was associated with an extra 4.5 kg gain over 15 years and a two-fold increase in insulin resistance.[22] Both studies that assessed fast-food intake found it to be associated with an additional 0.5[23]–0.7 lb/yr[22] above average weight gain.

The third study was part of the Nurses' Health Study II.[21] The researchers distinguished between different types of diet: a "Western" diet (high in red and processed meat, refined grains, potatoes, sweets, and desserts); a "prudent" diet (high in fruit and vegetables, whole grains, fish, and poultry); or a combination of the two. They examined changes in individual diets and associations with weight change over an 8-year period in 51,610 women aged 26 to 44 years at baseline. The

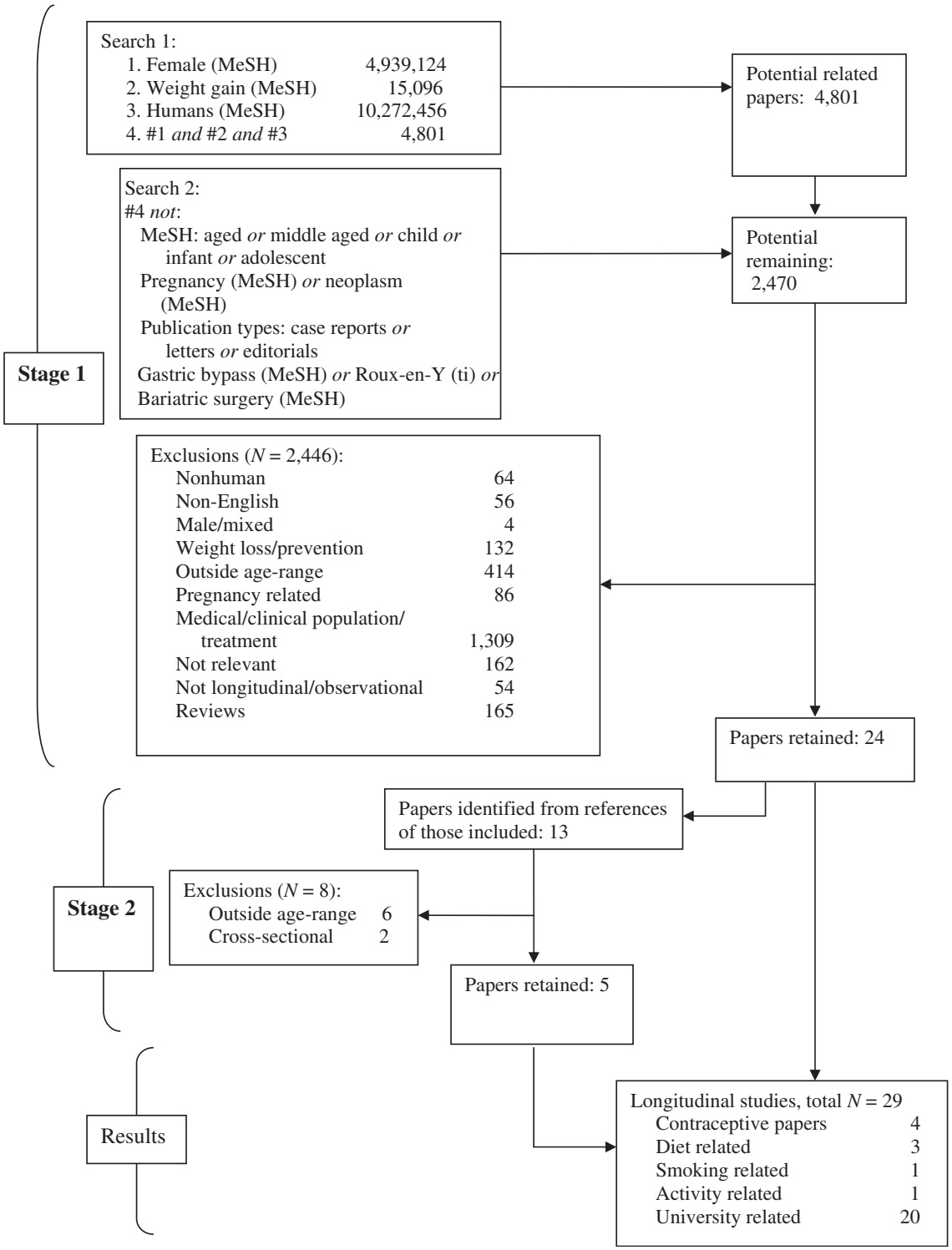

FIG. 1. Overview of the search process (Stage 1 : PubMed search; Stage 2 : reference search. [ti, In title].

Western diet was associated with an average weight gain of 17.2 lb over 8 years, whereas women who sustained a high prudent score were more likely to maintain their weight.[21]

The associations between weight gain and diet were also considered in some of the university studies. Seven of those studies[26,27,29,36,37,40,41] suggested that diet quality was a predictor of weight gain, with inadequate consumption of fruit and vegetables,[27,29,36,40,41] low fiber,[26] and high fat/cholesterol[26,27,37] diets being commonplace among the students. Of these seven studies, five measured diet/dietary changes using a dietary behavior questionnaire,[26,29,37,40,41] while two measured diet using a food frequency questionnaire (FFQ).[27,36]

Table 1. Summary of Studies Describing Weight Change with Contraception Use

Reference	*Study* *Number of women* *Age* *Study duration* *Location* *Number of assessments*	*Type of contraception*	*Outcome measures*	*Weight gain/lost/stable, as concluded by authors*	*Authors' conclusions*
			OC		
Lech MM, Ostrowska L, 2002[20]	700 24.37 ± 5.95 yrs, 18–40 yrs 6 cycles Poland 3 assessments	OC	Obj: Weight	Stable: BMI pre: 21.0 ± 2.7 kg/m^2 BMI after 6 cycles: 20.97 ± 2.59 kg/m^2	No significant changes in weight
Rosenberg M, 1998[18]	128 18–35 years 4 cycles USA Daily weighing	OC	S-R: Weight	Stable: 52% no change (<2 lb difference) 28 % gained weight 20% lost weight	Little to no change in weight
			DMPA		
Said S, Omar K, 1986[19]	1,216 27.7 ± 5.0 yrs 12 months Egypt 5 assessments	DMPA (100 mg or 150 mg)	Obj: Weight	Gain: 0.81 lb/3 mths; equivalent to 3.26 lb/yr (95% CI = 2.84, 3.65 lb) No significant differences found between doses	
			Comparison study		
Bahamondes L, et al, 2001[17]	206 33.1 ± 0.7 yrs 5 yrs Brazil 6 assessments	DMPA (150 mg) IUD	Obj: Weight	Gain: DMPA: 9.5 lb over 5 yrs ($p \leq 0.05$) IUD: 3.96 lb over 5 yrs ($p \leq 0.05$)	DMPA users gained significantly more weight than the IUD users; increase became significant after 2 yrs; age-associated weight gain thought to be a factor

BMI, body mass index: BMI ≤ 18.5, underweight; 18.5–24.9, normal; 25–29.9, overweight (ov); >30, obese (ob) (unless otherwise stated); DMPA, depot medroxyprogesterone acetate; IUD, intra-uterine device; kg, kilograms; mths, months; Obj, objective measures; OC, oral contraceptive; SD, standard deviation; S-R, self-report measures; wks, weeks; yrs, years.

Table 2. Summary of Studies Describing Weight Change with Dietary Behaviors

Reference	*Study title* *Number of women* *Age* *Duration and dates* *Location* *Number of assessments*	*Measurement*	*Weight gain/outcomes*	*Conclusions*
Schulze MB, et al, 2006[21]	Nurses' Health Survey II 51,670 26–44 yrs 8 yrs 1991–99 United States 3 assessments	S-R: Weight, height, dietary assessment—prudent vs Western pattern	High Western diet 12.36 lb Low Western diet 10.78 lb Increased Western 17.18 lb Decreased Western 8.88 lb Increased prudent 8.25 lb Decreased prudent 17.56 lb All values significant ($p \leq 0.001$)	Decreases in prudent score over time were associated with significant increases in weight
Pereira MA, et al, 2005[22]	CARDIA study 1,580 25.1 ± 3.6 yrs, 18–30 yrs 15 yrs 1985/6–2000/1 United States 6 assessments	Obj: Weight, height, WC, insulin and glucose concentrations S-R: PA history questionnaire Dietary assessment	Frequent f-f: consumers at baseline and follow-up: Extra + 9.9 lb WG ($p < 0.05$) Two-fold greater increase in insulin resistance	Change in f-f consumption over 15 yrs was independently associated with changes in weight
French SA, et al, 2000[23]	POP study 891 35 yrs; 20–45 years 3 yrs United States 4 assessments	Obj: Weight, height S-R: Dietary intake, F-f use PA Eating behaviors Smoking	Average WG + 3.7 lb ($p = 0.01$) Increase of 1 f-f meal per week was associated with an increase of 56 kcal/day, 0.6% in fat energy/day, and a WG of 1.58 lb over 3 yrs; above average WG	Increases in f-f consumption were associated with higher fat and energy intake, greater body weight, higher intake of soft drinks, decreases in vegetable consumption, less restrained eating, and fewer low-fat behaviors

BMI, body mass index: BMI ≤ 18.5, underweight; 18.5–24.9, normal; 25–29.9, overweight (ov); >30, obese (ob) (unless otherwise stated); f-f, fast food; kg, kilograms; Obj, objective measures; PA, physical activity; POP, Pound of Prevention study; S–R, self-report measures; WG, weight gain; wks, weeks; yrs, years.

Table 3. Summary of Studies Describing Weight Change in and Transitions to a University

Reference	*Study* *Number of women* *Mean age ± SD and/or range* *Duration* *Location* *Number of assessments*	*Measurements*	*Weight change: gain/lost/stable*	*Authors' conclusions*
		First-Year Studies		
Economos CD, et al, 2008[29]	256 17.8 ± 0.5 yrs 8–9 mths United States Pre/post	Obj: Weight, height S-R: Weight, height Health behavior	Gain: mean ± SD Overall: + 5.5 ± 6.4 lbs ($p \leq 0.001$) Gainers (80.9%): + 7.6 ± 5.0 lbs ($p \leq 0.001$)	Stress and academic workload are positively correlated with WG
Edmonds MJ, et al, 2008[30]	116 18.5 ± 0.6 yrs, 17–20 yrs 7 mths' transition from high school to university Canada 3 assessments	Obj: Weight, height BC using BIA WC S-R: 24-hour diet recall Demographics Lifestyle	Gain: mean Overall: + 5.28 lb ($p < 0.03$) Overall rate of WG ~ + 0.24 lb/wk (summer–fall) ~ + 0.13 lb/wk (fall–winter) % ov increased from 15% to 22% WC increased 2.5 cm	Changes in moderate PA was an important predictor of weight
Jung ME, et al, 2008[35]	101 18.5 ± 0.6 yrs 1 year United States 4 assessments	Obj (pre/post only): Weight, height BC using BIA S-R: PA Food diary	Gain: mean ± SD Overall: + 3.08 ± 8.35 lbs Gainers (65%): + 7.54 ± 6.01 lbs ($p < 0.001$) Loss: mean ± SD Losers (34%): − 5.3 ± 5.26 lbs*; $p<0.001$	PA defining characteristic in freshman weight gain
Kasparek DG, et al, 2008[36]	169 17–19 yrs 6 mths United States Pre/post	S-R: Weight, height Lifestyle and behavioral questionnaire PA	Gain: mean Overall: 2.5 lbs ($p < 0.05$) Gainers (57%): range 1–35 lbs Initially normal weight: + 6.21 ± 4.27 lbs Initially ov/ob: + 10.96 ± 8.30 lbs	Weight gain 6.7x greater than that expected for US adults Baseline BMI is a factor in WG
Mihalopoulos NL, et al, 2008[38]	83 18.4 ± 0.5 yrs 7 mths United States Pre/post	S-R: Weight, height	Gain: mean Overall: + 1.7 lbs (CI 0-3.5) ($p = 0.09$) Gainers (51.3%): 7.5 lbs, range 5.6–9.4 lbs Rate of WG in weight gainers ~ 0.94 lb/mth Lost/stable: 15% lost weight 33% remained stable	Weight gain 5.5 times greater than in general population

Delinsky SS, Wilson G, 2007[28]	149 17.9 ± 0.5 yrs 7 mths United States Pre/post	Obj: Weight, height in randomly selected subgroup, $n = 44$ S-R: Weight, height Dietary habits Self-esteem Body shape	Gain: mean ± SD Overall: + 3.37 ± 7.48 lb ($p < 0.01$) Gainers (63%): + 7.26 ± 5.94 lb 9 women gained > 15 lbs % ov increased from 11.4% to 13.4%	Freshman 15 largely a myth, but significant weight gain seen in freshman year
Hull HR, et al, 2007[34]	69 18.3 yrs 1 yr United States 3 assessments	Obj: Weight, height BC using DEXA	Gain: mean + 2.86 lb over academic period FFM increase of 1.1 lb Significantly higher WG over academic period than summer period (gain [mean]: 0.22 lb) FFM decrease of 2.42 lb over summer period ($p < 0.01$)	Change in body composition—unfavorably over academic and summer periods
Hull HR, et al, 2006[45]	50 21.8 ± 4.1 yrs 13 ± 3 days (Thanksgiving) United States Pre/post	Obj: Weight, height, waist and hip circumference	Gain: mean 0.88 lb ($p < 0.05$) Correlation between BMI and weight gain ($r = 0.42$, $p < 0.01$)	Holiday season creates a high-risk environment for weight gain
Hajhosseini L, et al, 2006[31]	22 18.3 ± 0.02 yrs 16 wks United States 3 assessments	Obj: Weight, height BC using BIA RMR S-R: 3-day food intake diary	Gain: mean ± SD Overall: + 3.0 ± 0.7 lbs ($p = 0.001$) 59% gain ≥ 3lbs, 22% ≥ 6 lbs BMI and FM increase ($p \leq 0.002$) FFM decrease ($p = 0.001$)	3 lb increase in 16wks—this is equivalent to ~94 kcal/day excess energy intake
Hoffman DJ, et al, 2006[32]	35 Freshman 7 mths United States Pre/post	Obj: Weight, height BC using BIA	Gain: mean ± SD Overall: + 2.82 ± 6.03 lb Gainers: + 5.87 ± 3.81 lb BF: + 0.8 ± 4.8% FM: + 2.57 ± 6.49 lb BMI: + 0.98 ± 2.84 kg/m^2	In weight gainers 112 kcal/day positive energy balance over the 7-mth period—this is equivalent to a 27.28 lb gain by graduation if continued for the 4 years of college

(*continued*)

TABLE 3. (CONTINUED)

Reference	*Study* Number of women Mean age ± SD and/or range Duration Location Number of assessments	*Measurements*	*Weight change: gain/lost/stable*	*Authors' conclusions*
Lowe MR, et al, 2006[43]	69 18.1 yrs 8 mths United States 3 assessments	Obj: Weight, height S-R: Eating/dieting Weight and dieting history	Gain: mean Overall: + 4.58 lb 83% gained weight within 1st mth	Neither self-report overeating or Restrained eating predicted WG
Morrow M, et al, 2006[39]	137 18.2 ± 0.7 yrs, 18–20 yrs 1 academic yr United States Pre/post	Obj: Weight, height WC HC BC using DXA S-R: PA	Gain: mean ± SD Overall: + 2.42 ± 5.94 lb ($p \leq 0.001$) BMI, % fat, total fat, FFM, WC, and HC increase* $p<0.001$	Modest but significant increases in body weight and composition during first year at a university No significant changes in moderate or vigorous PA
Levitsky DA, et al, 2004[37]	51 18.2 yrs 12 wks United States Pre/post	Obj; Weight S-R; Lifestyle and behavioral questionnaire	Gain: mean ± SD Overall: + 4.18 ± 5.28 lb = ~ +0.35 lb/wk ($p \leq 0.01$) BMI increase* $p<0.01$	WG greater than in general population Evening snacking and increased high- fat foods best predictors of weight gain
Butler SZ, et al, 2004[27]	54 17.8 yrs 5 mths United States Pre/post	Obj: Weight, height BC using skinfolds Fitness assessment—VO2 max, recovery heart rate S-R: Diet by FFQ PA Self-efficacy	Gain: mean Overall: + 1.59 lbs ($p \leq 0.01$) BMI increase ($p \leq 0.01$) Fat increase of 1.79% ($p \leq 0.001$)	Decrease in PA seems to be the biggest contributor to WG
Anderson D, et al, 2003[44]	77 Sept–Dec: 77 Sept–May: 29 7.9 ± 0.5 yrs 3 mths United States 2 or 3 assessments	Obj: Weight, height S-R: Behavior, diet, drugs and alcohol questionnaire	Gain: mean Overall Sept–Dec: + 2.86 lb ($p < 0.01$) Gainers (70%) 26% gained > 5.06 lb ov/ob increase from 21% in Sept to 33% in Dec subgroup – Sept–May (mean): + 3.74 lb ($p < 0.01$)	WG occurs predominately at the beginning of the year since weight gain in the subgroup was significant from Sept–Dec, but NS from Dec–May

Graham M, et al, 2002[42]	39 18.5 yrs 1 academic yr United States Pre/post	Obj: Weight, height Body fat S-R: Eating attitudes	Gain: Gainers (59%): mean + 4.6 lbs Stable: No significant weight change seen Overall (range): −15 to +15 lbs	No significant effects on weight were seen after transition to a university
		Longer duration studies		
Racette SB, et al, 2008[40]	138 18 yrs 4 yrs From first yr until end of senior yr United States Pre/post	Obj: Weight, height S-R: Diet behavior Exercise	Gain: mean ± SD Overall: + 3.74 ± 9.9 lb ($p < 0.001$) Ov/ob increased from 15% to 23%*; $p = 0.004$ (M&F) Height increased ($p < 0.001$) BMI + 0.5 ± 1.6 kg/m^2 ($p < 0.001$)	Weight gain during freshman year does not continue throughout yrs at a university
Adams T, Rini A, 2007[26]	66 18–31 2 yrs United States Pre/post	Obj: Weight, height BC using skinfold measurements S-R: Weight, height Health behavior	Gain: BMI increase	Weight gain associated with: Alcohol consumption Maladaptive coping behaviors Caffeine intake Energy intake and dietary fiber
Hull HR, et al, 2007[33]	48 19.2 ± 0.4 yrs 2 yrs First yr to end of second yr United States 4 assessments	Obj: Weight, height BC using DXA S-R: NA	Gain: mean, first year: +2.64 lb FM +1.76 lb Stable: second year (mean) + 0.44 lb	Largest increase in weight in first year Living on campus/off campus: significant difference in BC—off campus more favorable changes to BC
Racette SB, et al, 2005[41]	154 18.1 ± 0.3 yrs 2 yrs Beginning of first yr to end of second yr (2 academic yrs) United States 2 or 3 assessments	Obj: Weight, height S-R: Diet Exercise	Gain: mean ± SD Overall: 3.96 ± 11.44 lb ($p < 0001$) Gainers (70%): + 9.02 ± 7.92 lb Subgroup $N = 118$ (66) measured during first year + 5.5 ± 11 lb ($p < 0.001$) 75% increased their BMI	PA and dietary behavior not meeting recommendations may contribute to weight gain

BC, body composition; BIA, bioelectrical impedance analysis; BMI, body mass index: BMI ≤ 18.5, underweight; 18.5–24.9, normal; 25–29.9, overweight (ov); >30, obese (ob) (unless otherwise stated); DEXA, dual energy X-ray absorptiometry; FFM, fat-free mass; FM, fat mass; (gainers)—average for only those who gained weight; FFQ, food frequency questionnaire; HC, hip circumference; kg, kilograms; lbs, pounds; M, males; mths, months; NA, not applicable; NS, not significant; Obj, objective measures; PA, physical activity; RMR, ; SD, standard deviation; S-R, self-report measures; WC, waist circumference; WG, weight gain; wks, weeks; yrs, years; % fat, percentage body fat; $VO2_{max}$, maximal oxygen consumption; RMR, resting metabolic rate.

The use of the FFQ allowed one study to report changes in caloric intake.[27] In that study, while average caloric intake decreased by 349 kcal/day over the five-month period, consumption of alcohol and percent fat intake increased, and fruit and vegetable intake decreased.[27] Despite the decrease in caloric intake there was an overall weight increase of 1.61 lb; decreasing physical activity was purported to be the main contributor to this weight gain.

Smoking

Only one paper[24] reported on the association between weight gain and quitting smoking in women in this age group. The study was part of the European Community Respiratory Health Survey II, carried out in Germany. The researchers followed 3,368 women for an average of 8.9 years, with objective measures of weight. They reported that average weight gain was higher in quitters (1.72 lb) than in continuing smokers (0.92 lb), never-smokers (1.17 lb), and restarters (0.48 lb).

Activity

Only one[25] of the 29 papers assessed the relationship between leisure time PA and weight gain. This study was carried out as part of the CARDIA study. A group of 1,541 women completed 5 assessments over a 10-year period, with self-report measures of vigorous PA ($\geq$6 METS) and objective measures of weight. There was an inverse association between PA and weight change, with a stronger association in those who were overweight at baseline.

Changes in PA levels (increased, maintained, or decreased) between years 2 and 5 and again between years 5 and 7 of the 10-year study period were compared with body weight change. The majority of the participants maintained their activity level between 2 and 5 years and again between 5 and 7 years and gained 2.42 lb/yr; those who decreased their PA level and maintained this decrease gained the same amount of weight, on average 2.38 lb/yr; participants who increased and maintained their PA level had the smallest weight gain (0.81 lb/yr). These women, however, comprised only 6% of the total sample.

Six of the university papers specifically associated a decline in PA levels with increases in weight.[27,30,35,36,40,41] All papers used self-report measures of PA. Of these 6 papers, half based their questionnaires on the American College of Sports Medicine guidelines.[36,40,41] The questions asked about vigorous exercise (exercise that raises the heart rate or causes sweating) in bouts of at least 20 minutes on 3 to 5 days of the week.[36, 40,41] Two papers considered physical activity of different intensities: mild, moderate and/or vigorous.[30,35] Butler et al.[27] examined PA in different "dimensions"—work, sports, leisure time, and total PA—in the previous 4 months. Three of the studies also included strength training items in their questionnaires.[30,40,41]

Attending a university

More than half of the identified papers (20/29)[26–46] addressed weight gain while at a university or during the transition from high school to a university. Details of these studies are reported in Table 3. Eight studies included baseline and up to four follow-up measurements.[30,31,33–35,41,43,44] The average number of women in each study was 94, with a range of 22[31] to 256.[29] Four studies included <50 women,[31,32,42,46] 8 studies included 50 to 100 women,[26,27,34,37,38,43–45] and 8 studies included >100 women.[28–30,35,36,39–41] Eighteen studies measured weight objectively, and 9 of those collected body composition data using bioelectrical impedance analysis (BIA),[30–32,35] dual energy X-ray absorptiometry (DXA),[33,34,39] or skinfolds.[26,27] Most of these studies also collected self-report data on PA[27,30,,35–37,39–41,44] and dietary behaviors.[26–31,35–37,42,43]

The majority of these studies, 15 out of 20,[27–32,34–39,42,43,44] considered weight gain while students were in their first (freshman) year at the university. The mean duration of these 15 studies was 6.7 months, ranging from 12 weeks[37] to 1 year.[35] Nineteen studies were carried out in the U.S. and one in Canada.[30] All except one observed an increase in weight, with 2[36,38] noting that the rate of weight gain was 5.5 to 6.7 times greater than that seen in the general population of American adults aged 18 to 74 years. Only one study found no significant change in weight over a one-year period but observed a wide variation in weight change, from a loss of (15 lb) to a gain of (15 lb), with 59% of the female students gaining weight.[42]

In general, studies of women in their first year at a university showed that women gained weight at a higher rate during the first semester than during later periods of their university career. For example, Levitsky et al.[37] reported a gain of 4.18 lb over 12 weeks in the first semester. Canadian researchers, who examined the transition from high school to a university in 116 women, reported a 5.28 lb increase in weight from the summer prior to starting at a university to the end of first semester.[30] This rate of weight gain of 0.24 lb/week between summer and autumn, however, declined to 0.13 lb/week between autumn and winter. There was also a 2.5 cm increase in waist circumference in this study.[30] Anderson et al.[44] also reported that weight gain was higher between September and December (first semester) than in the period from December to March of the first year at a university (second semester).

Four papers reported weight gain over a longer period of time than the first year.[26,33,40,41] Three studies assessed weight from the beginning of the first year to the end of the second year[26,33,41]; all found an increase in weight over this time. Two of these studies[33,41] examined weight at midpoints between pre-assessments and post-assessments. Both found that the greatest weight gain occurred during the first year, which then tended to stabilize over the following year, with little extra weight being gained. One of these 4studies was then continued for four years and reported that 70% of students gained weight, with an average overall weight gain in women of 3.74 (SD 9.9) lb.[40]

One study of 50 female U.S. students, which assessed weight gain during the Thanksgiving holiday break, found that women gained an average of 0.88 lb ($p < 0.05$) during this period (average duration 13 ± 3 days). They also found that BMI was associated with weight gain, with overweight/obese participants gaining more weight than participants in the normal BMI category.[45]

While several of the 19 studies reported weight gain at a university without considering the reasons underlying it,[31,32,34,38,44,45] or were unable to determine potential causes,[28,39,43,46] others were able to identify possible determinants of weight gain during the university years. These included baseline weight/BMI,[36] decreasing PA,[26,27,35,40,41] poor-

quality diet with inadequate consumption of fruits and vegetables and increased high-fat foods,[29,36,37,40,41] increased alcohol consumption,[26,27] high levels of academic workload and stress,[29] and increased computer use.[30] Living accommodations were also shown to be important, with one study showing that higher weight gain occurred when living on campus than when living off campus.[33]

Discussion

Twenty-nine papers were located that reported weight change in nonclinical, nonpregnant female populations in the age range of 18 to 36 years, of which 27 studies reported weight gain. Weight gain was found to be associated with contraceptive use, dietary behavior (fast-food intake and Western-style diet), quitting smoking, decreasing physical activity levels, and university transition.

The majority (65%) of the studies in this review were carried out with university students. These papers showed that the first semester of the first year at a university was a critical time for weight gain[31,37,44] (an average gain of 3.3 lb was gained over the first 3 to 4 months[31,37,44]), with only slightly higher rates seen at the end of the academic year (4.18 lb over nine months[29,39,42]). However, little or no weight was gained in the subsequent years of study.[40] Since many of these studies reported that weight gain at this life stage is determined by a cluster of behaviors including diet, physical activity, alcohol consumption, and computer use, they were considered separately from the "single determinant" papers included in this review. Most university studies attributed weight gain to dietary behavior and decreasing/inadequate levels of PA.[27,35–37,40,41] This is in line with the general notion that weight gain is the result of an underlying energy-balance problem.[47] Transition to a university may evoke detrimental dietary and physical activity behaviors that lead to a larger imbalance between energy intake and energy expenditure. This inequality may be a particular problem during the holiday season when cultural and social influences combine to create a high-risk environment for weight gain.[45,48–50] However, few of the university studies considered changes in other behavioral factors that were addressed in the "single" determinant papers, such as smoking and contraceptive use.

The evidence for weight gain because of contraceptive use is varied. Several studies have now concluded that OC use does not seem to yield great weight gain. However, approximately 20% of the participants in one study gained between (2 to 5 lb) in 4 cycles; the authors referred to this as "minimal gain."[18] Another study of 54 undergraduate students, which was excluded since it was an intervention study, found an increase in weight of 2.86 lb with 3 months of OC use.[51] If this rate of weight gain (approximately 0.95 lb/month) continued, even for only 6 months, it would equate to approximately 5.72 lb, which could be significant in terms of population health. None of the OC papers provided data on long-term change.

DMPA use was associated with greater weight gain than other hormonal contraceptives. Reviews that have examined this issue have, however, been inconclusive, because of a lack of control information and variation in duration of studies.[52] Another study that examined the impact of DMPA on weight gain was located; however, it was part of a trial and therefore excluded from this review.[53] This paper reported the results of three trials conducted in the U.S. and Europe, two of which were carried out for a year and the third for three years. The combined trials, which observed more than 2,300 women (aged 18 to 35), reported modest weight gain (<5.06 lb at 12 months) with large individual variation.[53] Since studies that assessed only the first few months[18] of contraceptive use reported greater weight gain than those that examined changes over a longer period of time,[17] there may be some adjustment period, after which initial weight gain is discontinued or reduced. Although researchers are unsure of the true effects of contraception on weight, it is commonly cited as a primary reason for discontinuation of hormonal contraceptives.[52]

Three papers in this review specifically addressed the associations between dietary behavior and weight change; they concluded that dietary behaviors such as frequent fast-food intake and a Western-style diet are associated with weight gain. Many Western-style diets are low in fruits and vegetables, low in fiber, and high in processed meats. Furthermore, food prepared outside the home has been associated with higher calories and lower fiber, calcium, and iron intakes[54] and hence with increased BMI[55] and the reduced likelihood of weight maintenance (defined as remaining within 5% of baseline weight).[56] Young adults have been shown to be the highest consumers of fast food,[57] therefore making them a vulnerable group for weight gain.

Assessing the issue of quitting smoking was difficult, since only one paper with women in this age range was located. It reported that quitting smoking was associated with greater weight gain in quitters than in re-starters, continuing smokers, and never-smokers.[24] More papers were located, but since they focused on older populations, they were excluded from this review. The included paper raised the conundrum for health promotion workers that the adverse effects of weight gain may mask the health benefits of quitting smoking.[24] The need for controlling weight gain to get the full benefits of quitting is supported by Nilsson et al.,[58] who examined the effect of smoking cessation on the impact of other biological factors. They found that increases in weight may adversely influence glucose tolerance, insulin resistance, and lipid metabolism, negating some of the known positive benefits of smoking cessation. Women who want to quit smoking should be encouraged to be more active and limit their fast-food intake, so that these adverse effects are minimized.

Surprisingly, only one paper specifically assessed the association between physical activity and weight gain. Other PA papers either included older populations or did not report a change in weight. The association between declining PA and increasing weight, however, observed by Schmitz et al.,[25] is supported by the findings of some of the university papers[27,30,35,36,40,41] and by the Amsterdam Growth and Health Longitudinal Study.[59] Independent of the association between physical activity and weight change, the association between sedentary behavior and weight gain is becoming more prominent in obesity research.[47] One paper that focused on inactivity and weight gain was located; in it, Ball et al.[56] reported that an increase in sitting time was associated with a decreased likelihood of maintaining weight in young women. This paper was not included in this review since it did not report actual weight change.

The overall findings of this review confirm that young adulthood is a vulnerable time for weight gain. Unfortunately, most of the studies on weight gain in this

population were descriptive and focused on the general "lifestyle" experienced at a university rather than the specific determinants of weight gain. Nonetheless, the results confirm that university students are at risk of weight gain. Since for instance, as one example, 40% of young Australian adults now go to a university,[2] improved understanding of the relative contributions of the many lifestyle changes that occur at this life stage is now required if effective strategies to prevent weight gain are to be developed.

The conclusions of a review are dependent on the quality of the included studies. Based on the criteria used by von Elm et al.,[60] the overall quality of the papers included in this review was relatively high. Source populations, recruitment methods, and follow-up data were described in all papers. However, many of the studies had relatively small numbers of participants; for example, all the university studies had a range of between 22[38] to 256[29] participants, while 4 of the contraception papers ranged between 128[18] and 206[17] participants. However, all the papers on dietary behavior (with a range between 891[23] and 51,670),[21] the smoking paper ($N = 3{,}368$),[24] and the PA paper ($N = 2{,}770$)[25] included more than 500 participants. All the papers that reported BMI measures defined the cutoff points used for overweight and obesity. Only 4 of the 28 papers included in this review used self-reported weight data for their results: 2 of the university papers,[36,38] 1 contraception paper,[18] and 1 paper on dietary behavior.[21] Although all the diet papers, the PA study, and the smoking paper adjusted their results for potentially confounding demographic variables, only a few of the university studies[26,29,30,37] reported results that had been adjusted for demographic differences. This difference may have been because the majority of the participants in these studies were of similar age, largely from Caucasian backgrounds, and had a similar level of education, making adjustment for these factors unnecessary.

We acknowledge that this review has some limitations. Only one database (PubMed) was searched; other smaller searches were carried out with another database (Embase), but this did not result in additional papers that were not already identified in the PubMed search. For pragmatic reasons, only papers written in English were included, and this decision may have also limited our findings. As stated in the Introduction, although it is accepted that pregnancy is associated with weight gain in young women,[14,15] publications in this area are limited by a lack of information on concurrent health behaviors that affect weight gain during and after pregnancy. Pregnancy-related weight gain was therefore excluded from this search. It is acknowledged, however, that pregnancy is one of the leading causes of weight gain for women at this life stage,[61] and it is likely that excess weight gained during pregnancy is directly associated with subsequent obesity.[61]

Another limitation was that it was difficult to directly compare weight gain associated with the different determinants identified in this review, because weight gain was examined over different periods, and initial exposure to some determinants (eg, starting a new contraceptive going to university) was associated with higher rates of weight gain than prolonged exposure. More longer-term studies are clearly required. Moreover, while there was a strong focus on university students, not all young women attend a university. No studies were located that assessed weight gain in working women in this age group. It is therefore difficult to know whether university-related weight gain is comparable to weight gain in other groups of young women. This area is under-researched. Furthermore, since no studies have followed young women after they finish their university studies and start full-time work, questions relating to weight change during the transition from university to full-time work remain unanswered.

Conclusion

The aim of this paper was to review the literature on nonpregnancy-related determinants of weight gain in young women. Despite the documented high level of weight gain at this life stage, surprisingly few papers were found that focused on determinants of weight gain in women aged 18 to 36 yrs. Most research in this area has focused on the transition to and through a university. More studies are needed to assess the concurrent contributions of multiple determinants of weight gain in this population group. Given the known long-term adverse health effects of overweight and obesity,[6] more studies on weight gain and its determinants in nonuniversity populations are required.

Disclaimer Statement

The authors have no conflicts of interest to report.

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