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Research Article
Use of Herbal Remedies, Conventional Medicine, Diet and Exercise for Weight Loss: Case Study of University Students in Jordan

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Abstract

Objective: The purpose of this study was to explore the preferences of university students for use of herbal remedies, conventional medicine, diet and exercise for weight loss. **Methods:** This cross-sectional study applied a quantitative research approach using a self-administered questionnaire given to university students in Jordan. A literature review was conducted to search for clinical and experimental evidence concerning the effectiveness and side effects of herbal remedies and conventional medicines used for weight loss that appeared most often in the completed surveys. **Results:** The majority of university students in this study (83.0%) reported being overweight or obese, with a higher proportion among the male students. Of the obese or overweight students, 82% would prefer to use herbal remedies rather than conventional medicine for weight loss. Ten different types of herbal remedies and another 4 conventional medicines were found to be used by the students for weight loss. Of these, only 6 herbal remedies showed modest evidence to support effectiveness. The majority of students (76.6%) were on low calorie diet plans, while 64.9% declared they got adequate exercise, with significant differences between male and female students. **Conclusion:** This study highlighted that overweight and obesity are common issues faced by university students, that many students used herbal remedies for weight loss rather than diet or exercise. These findings indicate that universities should involve health-care professionals in discussions with their students about health risks associated with overweight and obesity and to advise them on safe and efficient treatments, as well as appropriate behaviors to achieve weight loss.

Key words: Diet and exercise, herbal remedies, weight loss, conventional medicine, obesity

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

A WHO report[1] defined obesity as a chronic disease characterized by an increase in body fat storage that can be assessed clinically and a body mass index (BMI) $\geq$30 kg m^{-2}. Individuals having a BMI ranging between 25-29.9 kg m^{-2} are categorized as overweight. Obesity is emerging globally as a leading, underlying contributor to a variety of different diseases such as diabetes, hypertension and cardiovascular problems.

Kilpi *et al.*[2] showed that the Middle East requires strategic prevention plans for obesity and its associated complications. Similarly, Ajlouni *et al.*[3] reported that obesity (BMI $\geq$30) is a common disorder among adult Jordanians that females 25 and older have a higher rate of obesity than males of a similar age (59.8% females vs. 32.7% males). This study also found a strong association of obesity with type 2 diabetes mellitus, hypertension and elevated blood lipid profiles. A similar study performed by Khader *et al.*[4] showed increased rates of obesity and its associated co-morbidities among Jordanians, especially for women aged 60 and older (53.1% females vs. 28.1% males).

Furthermore, a study by Al-Eitan *et al.*[5] involving a Jordanian population with type 2 diabetes showed that the 60.8% of participants who had unsatisfactory glycemic control also tended to have younger age at diabetes diagnosis, higher mean weight and higher prevalence of diabetic neuropathy, which are known common complications of obesity. These findings significantly correlated with low health-related quality of life among adolescents with overweight or obesity in Jordan[6]. Therefore, more attention needs to be paid to treat obesity as a health problem of national importance in Jordan. Special emphasis should also be placed on encouraging young adults to achieve and maintain a healthy body weight in order to avoid potential weight-related health complications at an early age.

Herbal products and herbal teas are widely marketed for their weight loss properties. Young adults seeking to keep their body weight within the accepted BMI ranges (18.5-24.9)[2] are particular targets of such marketing, as evidenced by the sales of non-prescription weight-loss herbal products in the United States totaling $2.4 billion in 2010, which was spent by the 34% of overweight or obese Americans individuals who are trying to lose weight[7]. Despite these strong sales, there is little evidence to support the effectiveness of these herbal products, which can also have multiple safety concerns such as herb-drug interactions or potential toxicity. Surveys in England and Australia found that at least 70% of community pharmacies stock these products and they can also be purchased through internet vendors in the form of tablets and capsules. Because of these formulations, many consumers may regard these compounds as medicines[8]. Therefore, the role of community pharmacists in supporting effective weight management is increasingly important.

This is the first study that aimed to determine the prevalence of herbal remedy (HR) and conventional medicine (CM) use to promote weight loss by university students (US) with overweight or obesity living in Jordan. The perceived efficacy and safety of these products, based on literature review, was also determined. The study also focused on university students attitudes toward diet and exercise intended to reduce body weight (BW).

MATERIALS AND METHODS

Study settings and design: This cross-sectional study was conducted at the Applied Science Private University, Amman, Jordan using a questionnaire distributed to male (MS) and female (FS) students. This study was approved by the Scientific Research Ethical Committee of the Applied Science Private University Faculty of Pharmacy and was conducted between March and June, 2016.

Questionnaire: A three-part, face-to-face self-administered questionnaire was developed by the principal researcher and was reviewed by three research experts for face validity. The questionnaire was then tested with 5 pharmacy students and 2 academics to judge the time needed for administration and to evaluate the clarity and logical flow of the questions.

The questionnaire included both closed (using a 5 point Likert scale) and open questions prepared by the principal researcher. The questionnaire was arranged in several sections: i) Section one concerned demographic information, including respondent BMI (kg m^{-2}) as calculated using BW (kg) and height (m) according to the equation described by Wuttisin *et al.*[9], ii) Section two collected specific information from the university students regarding HR and CM use for weight loss, focusing on university students beliefs about the safety and efficacy of the treatments they used, their sources of knowledge about these compounds and their overall experience and iii) Section three that covered university students behaviors and lifestyle measures, including diet plans and exercise.

The questionnaire was administered to participants by pharmacy students enrolled in the Applied Science Private University Phytotherapy course for the academic year 2015/2016 (n = 45). The students were trained on administration of the questionnaire as well as methods to assist in carrying out this study and to insure uniformity of data collection among the students. Each pharmacy student

was asked to approach 10 university students. The importance of data authenticity was explained to the university students before the questionnaire was administered. Participants were informed that all information provided was completely confidential and the results would be anonymized.

Following data collection, a literature review of peer-reviewed, published clinical, *in vitro* and *in vivo* studies concerning the safety and efficacy of the HR and CM that appeared most frequently among questionnaire responses was conducted. To rate the claimed efficacies of the HR and CM used by study participants, a comprehensive list of these treatments, as well as the frequency of use of each treatment, the type of studies performed with the main outcomes for each study and other health-relevant effects and complications reported by each study was compiled (Appendix 1). This appendix was used to correlate the frequency of inefficient use of these treatments among university students.

Sample size: A total of 400 students were included in the study. Based on the total number of students registered for academic year 2015/2016 (6,932) (2,638 females and 4,294 males), a sample size calculator (if margin of error = 5%, confidence level = 95% and response distribution = 50%) indicated that the minimum sample size for this study would be 365 students.

Statistical analysis: SPSS software was used for statistical analysis. Descriptive statistics such as frequency distributions were obtained. Data were also analyzed using the statistical package for social sciences (SPSS v.16. Chicago, IL, US). Categorical variables were described using frequency distribution and percentages. Mean and standard deviation were calculated for age variables.

RESULTS

Socio-demographic characteristics: A total of 384 out of 400 university students agreed to be surveyed, for a response rate of 96.0%. The mean values for female students (FS) were: height = 165.44 cm (±4.12 SD), BW = 69.70 kg (±10.09 SD) and BMI = 25.50 (±3.54 SD). For male students (MS) the mean values were: height = 176.53 cm (±5.91 SD), BW = 96.13 kg (±13.93 SD) and BMI = 30.98 (±4.14 SD). According to the respondent-supplied BW and height, the calculated BMI showed that the majority (83.0%) of sampled university students were overweight or obese (MS = 93.2% and FS = 74.0%, p = 0.014). The socio-demographic characteristics of the university students surveyed are presented in Table 1.

HR and CM used for weight loss by US: The majority (82%) of the sampled university students (MS = 75% and FS = 88%, p = 0.102) would prefer to use HR rather than CM for weight loss (Fig. 1). Among the HR users, 54% used a single HR, while the remainder said they used mixtures of 2-3 herbal materials. Of these, 18% of the formulas were based on green tea mixed with cinnamon or cumin, 17% were ginger-based remedies mixed with cinnamon, lemon or cumin and 7% of the formulas were composed of a mixture of turmeric, lemon, mint or cumin. A small percentage (4%) of the university students preferred to use non-crude herbal formulas provided by community pharmacies in the form of phyto-medicinal agents. Among the respondents, 5% of the university students were using CMs such as L-carnitine, alpha-lipoic acid or orlistat to manage their BW. Of those who used HR, 13% did not know the type that they used. Use of different forms of HR or CM was evaluated based on gender and no significant differences in usage rates were seen between male and female university students.

Efficacy and side effects of HR and CM used for weight loss by university students: A literature review was conducted to search for evidence concerning the efficacy and side effects of HR and CM used for weight loss by university students. These weight loss treatments were classified based on their mechanism of action and frequency of use (Appendix 1). The most commonly used HM were herbs and drugs that improve lipid profiles (19.3%, e.g., flaxseed, chamomile, sage, cinnamon, ginger, or alpha-lipoic acid), followed by treatments that increase energy expenditure (17.7%, e.g., green tea, bromelain enzyme). Treatments that improve insulin sensitivity or glucose intolerance were also used (14.5%, e.g., flaxseed, chamomile, cinnamon, ginger and alpha-lipoic acid) as weight loss treatments that were also shown to have antioxidant effects (12.4%, e.g., Rjel elasad, sage, turmeric, cinnamon, alpha-lipoic acid and different herb mixtures).

Other treatments had a moderate frequency of use and affect blood pressure (7.2%, e.g., flaxseed, cinnamon and alpha-lipoic acid), reduce inflammation (6.2%, e.g., flaxseed, pine apple and turmeric) or have a laxative effect (5.2%, e.g., senna). Meanwhile, digestive herbs used to stimulate gastric and bile secretions and bowel motility (e.g., Rjel elasad, chamomile and bromelain enzyme), which should be used with caution, were also reported by the university students to be used for weight loss (5.2% or respondents). Less frequently used treatments that increase fat oxidation or reduce fat synthesis (e.g., flaxseed and L-carnitine) were reported (3.1%), as were treatments that suppress appetite, such as flaxseed

Table 1: Socio-demographic characteristics of sampled university students (n = 384)

		Total (n = 384)	
Characteristics	Categories	n	%
Gender	Female	200	52.1
	Male	184	47.9
Age (years)	20-29	300	78.1
	30-39	52	13.5
	40-60	32	8.3
BMI (kg m^{-2})*	18.5-24.9 (healthy)	65	17.0
	25-29.9 (overweight)	184	47.9
	30 or higher (obese)	135	35.1

*Calculated and categorized according to (Wuttisin *et al.*[9])

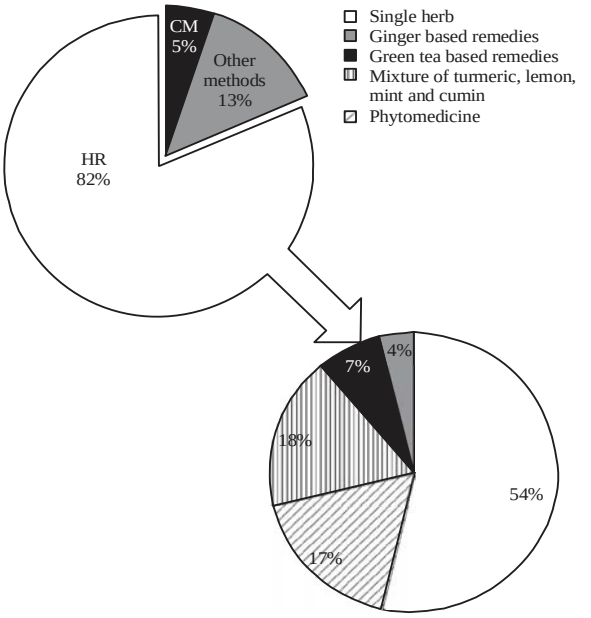

Fig. 1: US (n = 384) preferences for HR, CM or other methods to promote weight loss

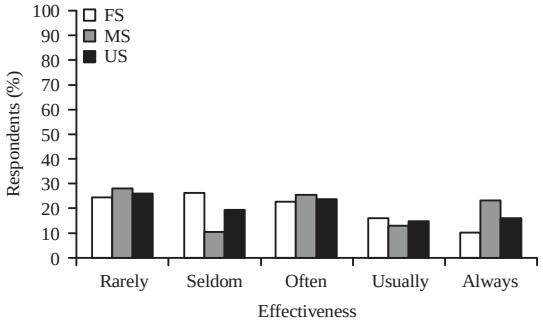

Fig. 2: Proportion of university students (n = 384) who believed that HRs are effective in reducing their BW

(1% of respondents). The sampled university students had relatively low usage of CMs that block dietary fat absorption such as orlistat (2%).

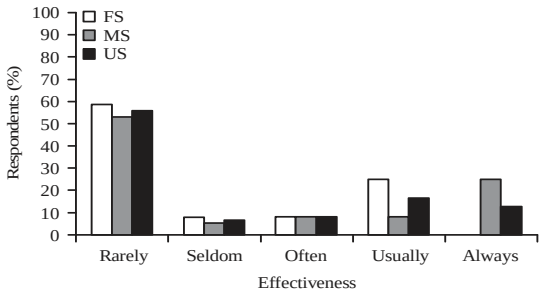

Fig. 3: Proportion of US (n = 384) who believed that CM are effective in reducing their BW

Knowledge and beliefs about HR and CM used for weight loss among university students: University students were asked to evaluate their experiences with the efficacy of the HR they used to reduce BW. About half (51.8%) (MS = 61.5% and FS = 48.9%, p = 0.229) believed that HR were effective or very effective in reducing their BW (frequencies ranging from often to usually to always) (Fig. 2).

University students were also asked to evaluate their experience concerning efficacy of the CM they used to reduce their BW. About one third (37.5%) of the university students (MS = 41.6% and FS = 33.3%, p = 0.015) believed that CM were effective or very effective in promoting BW loss (with frequencies ranging from often to usually to always) (Fig. 3). Only 18.3% of university students (MS = 18.1% and FS = 18.4%, p = 0.504) used a combination of HR with CM to reduce their BW (with frequencies ranging from often to usually to always).

A minority (9.6%) of the university students (MS = 6.8% and FS = 12.0%, p = 0.274) reported using non-natural treatments such as ACEI, anti-histamine, carbamazole, glucophage and thyroxine to treat health problems while using HR for weight loss. Therefore, we were interested in understanding their source of information and knowledge concerning their choice to use HR and to evaluate the potential for interactions among these compounds used in combination. The majority (70.2%) of university students (MS = 63.6% vs. FS = 76.0%, p = 0.191) declared that their first choice was HM. Unfortunately, less than one-third (29.8%) of the university students (MS = 36.4% and FS = 24.0%, p = 0.191) asked their pharmacist about which HR would be safe and efficacious for reducing BW.

Despite US certainty about HR safety, some (23.4%) university students (MS = 15.9% and FS = 30.0%, p = 0.232) reported side effects caused by HR used for weight loss (with frequencies ranging from often to usually to always) (Fig. 4). Reported side effects included stomach pain, anxiety, tachycardia, urination, constipation or diarrhea, spasms, drowsiness and menorrhagia.

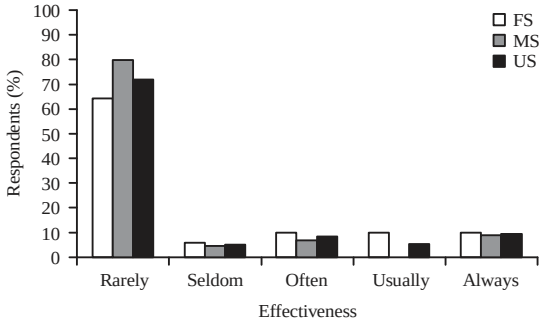

Fig. 4: Frequency of concerns over potential side effects associated with HR used for weight loss among US (n = 384)

Table 2: University students (n = 384) behaviors toward diet and exercise training with comparison between genders

Frequencies (%)	FS (n = 200) (%)	MS (n =184) (%)	US (n =384) (%)	p-value
Do you follow a low calorie diet plan to reduce the "extra kg" in your BW?				
Yes	70.0	84.1	76.6	p = 0.107
No	30.0	15.9	23.4	
What is the source of your diet plan?				
Personal	51.4	30.8	40.8	p = 0.050
Nutritionists	35.1	30.8	32.9	
Internet	13.5	28.2	21.1	
Friends	0.0	10.3	5.3	
How long have you followed your diet plan to reduce BW? (month)				
1 to <3	70.3	38.5	53.9	p = 0.034
3 to <6	13.5	17.9	15.8	
6 to <9	5.4	20.5	13.2	
9 to <12	2.7	15.4	9.2	
≥12 months	8.1	7.7	7.9	
How often do you exercise per week?				
5-7 days	56.0	75.0	64.9	p = 0.056
2-4 days	32.0	9.1	21.3	
1 days or less	5.2	15.9	13.8	
How long do you exercise each day? (min/day)				
15 to ≤29	41.7	31.8	37.0	p =0.028
30 to ≤44	31.3	18.2	25.0	
45 to ≤59	10.4	38.6	23.9	
60 to ≤74	6.3	6.8	6.5	
≥75	10.4	4.5	7.6	
How much of your monthly budget do you spend on visiting dietitians in their clinics or training in the gym? (JD)				
20-39	68.0	58.1	63.4	p = 0.751
40-59	14.0	16.3	15.1	
60-79	16.0	20.9	18.3	
80-99	2.0	2.3	2.2	
≥100	0.0	2.3	1.1	

Approximately half of the university students (53.1%, MS = 50.0% and FS = 56.0%, p = 0.379) reported that they obtained additional health benefits beyond reductions in BW when using HR. These benefits were mainly attributed to HR detoxification and tonic effects, including skin healing properties (18.2%), improving overall activity (15.5%) and relaxation effects (8.4%), as well as aiding in digestion (7.1%) and anti-flatulence effects (7.2%).

Behavior measures used by university students for weight loss: Table 2 summarizes diet and exercise measures taken by university students to reduce their BW, with comparisons between MS and FS. The majority (76.6%) of the university students (MS = 84.1% and FS = 70.0%; p = 0.107) followed a low calorie diet plan, for which they could not supply the composition or calorie intake.

Upon questioning the sources and duration (months) of their diet plans, significant variations (p≤0.050) were found between MS and FS. In general, 40.8% of the university students consumed meals based on their personal judgment of adequate nutrients and calories, especially FS. Only about one third (32.9%) of university students consumed meals

planned by nutritionists (with almost equal proportions between genders). Meanwhile, about one-fifth (21.1%) and 5.3% of university students depended on the internet and friends' experiences, respectively, for dietary information. MS in particular relied on internet and friends' experiences for information about diet plans. More than half (53.9%) of the university students said they had followed their diet plans (regardless of source) for between 1 and 3 months, with FS having followed diet plans for a shorter time compared to MS.

Most of university students (64.9%) reported exercising regularly (5-7 days/ week), with 63.0% indicating that they exercised $\geq$30 min/day. Significant variations ($p \leq 0.05$) were found between genders regarding their exercise training frequency and duration, with MS reporting more frequent and adequate exercise than FS.

In addition, the majority (63.4%) of university students declared that they may spend 20-40 JD/month from their monthly budget to reduce or maintain their healthy BW. These funds were spent either by consulting dietitians in student clinics or training at the university gym, no significant variations were seen between genders ($p \geq 0.050$).

DISCUSSION

A high proportion of overweight or obese university students was reported in this study, with higher frequency among MS. Overweight and obesity are often accompanied by various psychological and social effects, including low self-esteem, anxiety and depression, stigmatization, employment discrimination, college acceptance and overall employment[48]. In addition, Florin *et al.*[49] previously showed a negative association between obesity and academic achievements among American university students. Moreover, a review by Brewis[50] showed that overweight during adolescence has important social and economic consequences, which are greater than those of many other chronic or physical conditions and often are associated with discrimination toward overweight persons. Therefore, obesity and overweight are expected to influence university students health status, as well as their academic performance and social behaviors.

The majority of university students in this study preferred to use HR rather than CM for weight loss and also believed that HR had high efficacy for reducing BW, compared to one-third that believed CM is effective for weight loss. These findings are in contrast to those from a multi-state American survey conducted by Blanck *et al.*[51] showing that only 7% of adults used over the counter weight-reducing supplements, with the greatest use seen among young obese females (28%). These varying results could be caused by differences in study design, sample size and age group, as well as different cultural beliefs and knowledge between the two study populations. Moreover, different regulations and rules regarding herbal supplements used for weight loss between the countries may influence the frequency and awareness of their use[52].

Given the medical and psychosocial impact of being overweight, as well as the difficulty in making sustained improvements in diet and physical activity, it is not surprising that university students often turn to weight-loss products containing single or multiple ingredients (e.g., herbs, L-carnitine, alpha-lipoic acid, orlistat) for different reasons, including frustration with previous attempts at dieting and/or exercise, recommendations for affordable HR made by herbalists working at herbal stores, the ready availability of HR from community pharmacies without a prescription for use as phyto-medicine formulas, the claimed effectiveness over CM and the perception that natural always equals safe. Respondents also reported using HR for weight loss that they believed also provided other health promoting effects[53].

In this study, modest evidence for effectiveness was available for Rjel elasad (if used in combination with other herbs, but not alone), chamomile, bromelain enzyme, flaxseed, ginger (if used in combination with other herbs) and green tea, which showed weight loss effects as reported by different clinical and animal studies. Senna showed weight loss effects in animals but not clinically, whereas cinnamon extract had weight loss effects in an animal model of diabetes, but not in healthy subjects. Of the CM used, clinical studies showed that only alpha-lipoic acid and orlistat had moderate effects on BW. Similar findings were previously reported in a review by Sun *et al.*[53] that 50 individual dietary supplements and 125 commercial mixtures of natural materials were available in the American market that had no proof of promoting weight loss.

More than half of the university students in this study believed that HR had multiple positive health effects in addition to promoting weight loss, such as increasing their overall activity, providing skin benefits and aiding digestive system function[54] and therefore some used HR combined with medications for other chronic conditions. Many of these herbs have not yet been studied for weight loss in humans and long-term use of these supplements could cause adverse effects (e.g., dehydration, electrolyte abnormalities)[55]. A previous study by Vitalone *et al.*[56] conducted in Italy that measured the adverse reactions caused by the consumption of HR for weight loss, 46% of suspected adverse reactions were associated with herbal product use and 85% of the reports were made by women. Similarly, these adverse reactions were expected to appear among the university students in this study, given that the majority of them and

particularly FS, obtained their information on HR use from herbalists rather than from pharmacists. These findings highlight the possibility of side effects and adverse reactions arising from unsupervised use of HR as well as potential herb-drug interactions, which may inversely influence health conditions. Nonetheless, only a minority of university students in this study expressed concerns about these negative effects. As such, universities should encourage their students to participate in consultation sessions provided by professional practitioners and pharmacists, to increase their awareness of these potential negative effects.

Most of the university students in this study declared being on a low calorie diet plan with the goal of weight loss and depended on plans that they themselves designed. More FS than MS depended on self-designed plans, whereas MS tended to choose diet plans based on information obtained from friends or the internet. In addition, half of the university students had followed their diet plans for only 1-3 months, with FS having shorter durations of diets compared to MS. Overall, the university students reported undertaking regular and adequate exercise, with MS reporting having exercised more frequently and for longer than FS. The American College of Sports Medicine and the American Heart Association[57] recommend that in order to promote and maintain health, or prevent unhealthy weight gain, all healthy adults aged 18-65 years should perform moderate intensity aerobic physical activity for a minimum of 30 min 5 days a week.

Overall, the findings from this study suggest that FS could have an increased risk of future obesity, as they showed poor knowledge regarding the supplements they used for weight loss, as well as taking inadequate diet and exercise measures to reduce or maintain BW.

Among the challenges the university students encountered in achieving a healthy BMI are the high cost of university gym memberships (ranging from 18-25 JD/month). Moreover, the university gym maintains hours that may not be convenient to the university students schedules and off-campus gym memberships are even more expensive. Consultation sessions with clinical dietitians are also expensive (estimated range from 35-60 JD/month) and these professionals are not located on the university campus.

This study has some limitations. The use of self-reported data means that some respondents could report inaccurate BW or height, as well as the HR and CM used for weight loss. Diet plans and exercise frequency assessed by self-reported questionnaires are subject to bias that can affect data accuracy. Nonetheless, for such a survey, the use of a questionnaire is the most feasible way to measure use of HR, CM, diet and exercise for weight loss among the university students.

CONCLUSION

A high proportion of overweight or obese university students was reported in this study. The majority of university students preferred to use HR rather than CM for weight loss, on the basis that HR have higher perceived efficacy as well as positive health benefits. For the HR that were reported to be used by the university students, a literature review showed modest evidence for HR effectiveness in clinical and animal studies, with a lack of studies performed on humans. In addition, most university students declared that they were following a low calorie diet plan and performed physical exercise to promote weight loss, especially among MS. According to the current findings, FS could experience an increased risk of future obesity not only due to their poor knowledge of the supplements they used for weight loss, but also inefficient diet and exercise measures they used to achieve optimal BW.

SIGNIFICANCE STATEMENT

This study revealed a high proportion of weight loss supplement use by university students in Amman, Jordan and that the reported use did not meet the criteria for recommended use. Such findings highlight the significant role of universities in increasing students' awareness of possible health risks associated with the random use of HR or CM for weight loss. Universities can increase such knowledge by conducting regular scientific lectures and providing workshops led by health care professionals. Results from this study also emphasize the need for stronger regulations for the use and supply of HR used to promote weight loss, in addition to increasing the knowledge and practice of herbalists for the safe and efficacious use of herbs to control weight.

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Appendix 1: Review of peer-reviewed, published clinical, *in vivo* and *in vitro* evidence for HR and CM commonly used by US

Treatment	Frequency (%)	Study	Main outcome	Other relevant effects and complications	References
Chamomile (*Matricaria recutita*)	1	*In vivo* treatment of insulin-resistant high-fat diet fed mice with chamomile extract	No effect	Considerably reduced insulin resistance, glucose intolerance, plasma triacylglycerol, non-esterified fatty acids and LDL/VLDL cholesterol, with preventive effect on fatty liver formation and hepatic inflammation, indicating hepatoprotective effects	Weidner *et al.*[10]
Flaxseed (*Linum usitatissimum*)	1	In a clinical study flaxseed was added to a weight loss diet for men with cardiovascular risk factors	Weight loss and systolic blood pressure reduction	Decrease in inflammation markers, improved insulin sensitivity via decrease in oxidative stress and fat accumulation on vital organs, i.e., "visceral fat", improved lipid profile and control of blood pressure	Cassani *et al.*[11]; Park and Velasquez[12], Rhee and Brunt[13]
		Clinical study of effects of a small dose of flaxseed fiber included in the diet of obese individuals with pre-diabetes	Reduced weight	Significantly suppressed appetite and energy intake	Hutchins *et al.*[14]; Ibrugger *et al.*[15]
Pineapple (*Ananas comosus*)	2.1	Both *in vitro* and *in vivo*	No effect	Proteolytic activity of bromelain was shown to have anti-inflammatory and immunomodulatory effects, hormone like properties, with fibrinolytic activity	Tochi *et al.*[16]
		In vivo	No effect	Anti-inflammatory effect due to proteolytic activity	Hale *et al.*[17]
Rjel elasad; syn.: lady's mantle; *(Alchemilla vulgaris)*	2.1	STZ diabetes mice	Weight reduction in obese subjects despite lack of antihyperglycemic activity	Antioxidative properties	Afifi and Kasabri[18], Swanston-Flatt *et al.*[19]
Mixture of extracts from *Alchemilla vulgaris, Olea europaea*, *Mentha longifolia* leaves with cuminum cyminum seeds Known as "Weighlevel" not used in this study		Preclinical *in vitro* and *in vivo* studies, including a preliminary, uncontrolled human trial	Safe and effective in weight loss formula by increasing thermogenesis in brown adipocytes	*Alchemilla vulgaris* tannins increase metabolic rate and flavonoids regulate digestive enzymes with cardioprotective effects; olive leaf extracts inhibit intestinal glucose absorption causing hypoglycemic effect with hypotensive and hypolipidemic properties and also reduce fat load and circulatory fat levels; mint increases gastric emptying and passage of food throughout the digestive system; cumin reportedly improves glucose utilization, reduces raised blood sugar and promotes digestion by stimulating gastrointestinal mucosa and pancreatic digestive enzymes	Said *et al.*[20]
Sage (*Salvia officinalis*)	2.1	Healthy female volunteers	No effect	Tea was effective in the improving lipid profiles, antioxidant defenses with no effect on glucose regulation	Sa *et al.*[21]
Tumeric (*Curcuma longa*)	3.1	Genetically diabetic mice and rats	No effect	Hypoglycemic effects	Kuroda *et al.*[22]
		Alloxan-induced diabetic rats	No effect	Significant reduction in blood sugar, Hb and glycosylated hemoglobin levels. Also reduction in oxidative stress in diabetic rats	Arun and Nalini[23]
			Not studied	Possesses antioxidant, anti-inflammatory and anti-mutagenic properties and protects the body from mutagens	Jayaprakasha *et al.*[24]
Senna (*Cassia angustifolia*)	5.2	Randomized, placebo-controlled trial included patients with chronic constipation	No effect	Laxative efficacy and is a safe alternative option for the treatment of constipation; Chronic abuse may cause serious fluid and electrolyte loss, with chronic diarrhea	Picon *et al.*[25], Cirillo and Capasso[26], Izzy *et al.*[27]
		Male Wistar rats fed diet containing *Cassia senna*	Body weight loss	Inefficiency of feed utilization, diarrhea, ruffled hair and enterohepato nephrotoxicity	Adam *et al.*[28]
Cinnamon (*Cinnamomum verum*)	5.2	Patients with type 2 diabetes	Attenuation of weight loss associated with diabetes	Reduced mean fasting serum glucose, TAG, total cholesterol and LDL and increased circulating insulin levels	Ranasinghe *et al.*[29]

Appendix 1: Continue

Treatment	Frequency (%)	Study	Main outcome	Other relevant effects and complications	References
		Animal and human studies involving subjects with metabolic syndrome, type 2 diabetes and polycystic ovary syndrome	Decreased body fat percentage and increased lean body mass vs. placebo group	Improved insulin sensitivity, glucose tolerance, fasting blood glucose, blood lipid profile, systolic blood pressure	Anderson[30]
		STZ-induced diabetic rats treated with cinnamon oil	Significant decrease in body weight vs. normal rats	Hypoglycemic, hypolipidemic and antioxidant effects with significant decrease in protein and uric acid levels	Al-Logmani and Zari[31]
Ginger (*Zingiber officinale*)	6.3	Healthy subjects taking a combination supplement containing raspberry ketone, caffeine, capsaicin, garlic, ginger and *Citrus aurantium*	Reduced body weight, fat mass, waist and hip circumference, when used along with dieting	Unclear whether ginger is the cause of weight loss	Lopez *et al.*[32]
		Mouse (obese gold thioglucose)	Significant decrease in body weight vs. placebo	Significant decrease in serum chol, TG, glucose and insulin	Goyal and Kadnur[33]
Green tea (*Camellia sinensis*)	15.6	Healthy men	Stimulate thermogenesis and fat oxidation and thus could influence body weight and body composition if were standardized to caffeine and catechin polyphenol high content	Effect of the green tea extract on the metabolic rate represents an increase in energy expenditure and changes in substrate utilization	Dulloo *et al.*[34]
		Overweight and moderately obese male and female subjects	Did not improve weight maintenance after weight loss	Stronger weight maintenance effect for green tea in low caffeine consumers compared with the high caffeine consumers indicates that the magnitude of habitual caffeine intake may affect the effectiveness of green tea administration	Kovacs *et al.*[35]
		Obese mouse	Significant decrease in body weight compared to placebo	Dose-dependent and significant decrease in hepatic steatosis; Liver enzymes also decreased associated with lower serum ALT and AST activities	Bruno *et al.*[36]
Via ananas	2.1	Commercial product		Bromelain enzyme helps stimulate digestion enhancing the process of burning body fat	Anonymous[37]
L-carnitine	2.1	Moderately obese women	When combined with aerobic training does not promote weight loss		Villani *et al.*[38]
		No trials demonstrated that L-carnitine is effective for weight loss	Uncertain	Increase fat oxidation or reduce fat synthesis; product efficiency is uncertain and should be used with caution and under monitoring	Saper *et al.*[39]
Alpha-lipoic acid	1	Non-insulin dependent diabetes mellitus patients	No effect	Increase insulin-stimulated glucose disposal	Jacob *et al.*[40]
		Animal study	Weight loss effect	Potent antioxidant and free radical scavenger ameliorates insulin resistance and atherogenic dyslipidemia, as well as lowers blood pressure	Pershadsingh[41]
		People met criteria according to	In both groups, significant	In both groups, significant reductions in blood pressure were	Carbonelli *et al.*[42]

Appendix 1: Continue

Treatment	Frequency (%)	Study	Main outcome	Other relevant effects and complications	References
		body mass index (BMI), obese and pre-obese	reductions in weight, BMI and abdominal circumference were observed	observed	
		Chinese Han ethnicity with a BMI $\geq$25 kg m^{-2}	Mild weight loss accompanied by reduction in waist circumference	No significant differences were noted in terms of cholesterol levels, triglyceride levels and high-density lipoprotein cholesterol levels	Li *et al.*[43]
Orlistat	2	Only FDA-approved medication for treatment of obesity in adolescents		Decreases GI lumen absorption of dietary fat (triacylglycerol) by reversibly inhibiting gastric and pancreatic lipase-mediated triglyceride hydrolysis, thereby decreasing intestinal concentrations of absorbable free fatty acids and monoglycerides	Genentech[44]
		Severely obese African-American and Caucasian adolescents	Small but significant improvement in BMI compared to placebo among obese adolescents with obesity-related comorbidities	Inhibits pancreatic lipase, reducing digestion and absorption of fats from the small intestine by ~30%	Condarco *et al.*[45]
		Clinical trials	Significantly greater weight loss compared with placebo		Haslam[46]
Royal slim: extract of several plants	1	No trials on the mixture	Very useful for controlling obesity, hyperlipidemia and sugar craving	Regulate body metabolism, reduce fat deposition and improve immune system function, block excessive appetite for food and removes excess fat from adipose tissues	Anonymous[47]

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