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PHYSICAL ACTIVITY, HEALTH AND EXERCISE

Integrating needs-supportive delivery into a laboratory-based randomised controlled trial for adolescent girls with overweight and obesity: Theoretical underpinning and 12-week psychological outcomes

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ABSTRACT

When designing efficacy trials, researchers have a responsibility to "do no harm" and to "do good". Given the psychological vulnerability of adolescent girls with overweight and obesity, it is important to consider the implications of participating in weight-related research studies. We investigated psychological outcomes from a 12-week laboratory-based randomised controlled trial aimed at improving body composition and bone health in adolescent girls with overweight and obesity. Sixty-three participants were randomised to three groups (Recommended dairy diet plus exercise (RDa, n = 24); Low dairy diet plus exercise (LDa, n = 25); no-intervention control (n = 14)). Self-Determination Theory-informed strategies were applied in both intervention groups to foster motivation and enhance psychological wellbeing. Motivation, perceived competence and self-perceptions were measured at 0 and 12 weeks. Fifty-four participants (24 RDa, 23 LDa, 7 Control) provided complete psychological data. There were no between group differences in 0- to 12-week change in motivation, perceived competence or global self-worth. Both intervention groups showed significant improvements in physical self-worth ($p = 0.001$), body satisfaction ($p = 0.002$) and perceived physical conditioning ($p = 0.002$), compared with the control group. A theory-informed, laboratory-based diet and exercise intervention produced favourable psychological outcomes for adolescent girls with overweight and obesity.

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KEYWORDS
Motivation; self-perceptions; perceived competence; adolescent obesity; intervention; self-determination theory; needs-supportive delivery; behaviour change

Introduction

With prevalence rates continuing to rise worldwide, child and adolescent obesity remains a major public health concern (NCD Risk Factor Collaboration, 2020). Data from electronic medical records in Ontario, Canada, showed 34% of adolescent boys and 24.7% of adolescent girls were overweight or obese in 2013 (Biro et al., 2016). Adolescence is a critical period characterised by physical, psychosocial and environmental change (Sessa, 2016) and presents an opportune time to adopt healthy behaviours to underpin the transition into young adulthood (Hayes et al., 2019). Evidence supports multicomponent interventions that incorporate physical activity (usually in the form of structured exercise), diet and behaviour modification for weight management in adolescence (Militello et al., 2018). Whilst systematic review data show positive effects for reducing adiposity, there remains a need for more rigorous assessment of psychological outcomes (Militello et al., 2018).

The need to investigate psychological outcomes is particularly pertinent for efficacy trials conducted in university research laboratories, which are often focused on the effects of specific diet and/or exercise regimens on physiological or anthropometric health outcomes (e.g., Lee et al., 2013; Li et al., 2017; Lopes et al., 2016). Adherence strategies may be employed to reduce loss to follow-up, but it is rare for such trials to provide a behavioural support component or to consider the impact of the intervention on participants' psychological wellbeing and longer-term health behaviours. For interventions targeted at adolescents with obesity, consideration of this psychological aspect is crucial. Not only does this population suffer low self-esteem and impaired quality of life (Griffiths et al., 2010), but study participation may heighten focus on weight, which in turn has been shown to have negative implications for self-esteem (Jones et al., 2018). This potential to cause psychological harm must be considered when designing efficacy trials, even when the research question is not psychology-focused.

Two recent systematic reviews have investigated the effects of multicomponent weight management interventions on self-esteem in adolescents (Murray et al., 2017) and in children and adolescents combined (Gow et al., 2020). Whilst meta-analyses of randomised controlled trials (RCTs) within each of the reviews (Murray et al., 2017 n = 7 studies; Gow et al., 2020 n = 12 studies) showed no difference in changes in self-esteem between intervention and control groups, Gow et al.'s (2020) more inclusive meta-analysis of 49 studies (that also included pre-post and non-RCT designs) demonstrated a small positive effect on self-esteem both at post-intervention and at follow-up in those with available data

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(n = 17 studies). The 49 studies included in Gow et al.'s (2020) review were however conducted in community and clinical settings (rather than university research laboratories), of which 45/49 reported the inclusion of behavioural change components within the intervention. Further research is therefore needed to investigate the psychological impact of weight-related efficacy trials conducted in laboratory settings, where the focus on experimental control risks overriding the promotion of psychological wellbeing and long-term behavioural change.

Given the heightened self-consciousness (Cowley et al., 2021) and risks related to body dissatisfaction (e.g., disordered eating, depression) in adolescent girls in particular (Sonneville et al., 2012), drawing on psychological theory to inform interventions may help promote a healthy relationship with weight, diet and physical activity behaviours. Although there are many examples of multicomponent weight management interventions that incorporate behaviour change strategies, few studies report theoretical underpinnings (Militello et al., 2018). The theoretical grounding of an intervention is important for replicating good practice, and can enhance our understanding of the mechanisms through which interventions lead to behaviour change. One theory that has been used extensively in the design of lifestyle interventions is Self-Determination Theory (SDT, Ryan & Deci, 2000, 2017). SDT focusses on how person–environment interactions influence the quality of motivation, which in turn enhances psychological wellbeing and behavioural persistence. Whilst the use of SDT has shown favourable effects in community-based interventions for adolescents with overweight and obesity (Fenner et al., 2016, 2013), to our knowledge SDT has not been drawn upon within laboratory-based efficacy trials where the primary focus is on manipulation of either diet or exercise variables.

In this paper, we report 12-week psychological outcomes from a laboratory-based randomised controlled trial designed to compare the effects of a recommended dairy diet plus exercise (RDa), a low-dairy diet plus exercise (LDa) and a no-intervention control in adolescent girls with overweight and obesity (Calleja et al., 2020; Josse et al., 2020). In designing the trial, we were mindful of our ethical responsibility to abide by the principles of "non-maleficence" (first do no harm) and "beneficence" (do as much good as you can) (Beauchamp & Childress, 2013). Specifically, given the risks associated with body dissatisfaction in adolescent girls (Sonneville et al., 2012) and the evidence favouring a multicomponent approach to adolescent weight management (Militello et al., 2018), we underpinned intervention delivery with SDT-informed motivation and behaviour change strategies. In doing so, we hoped to reduce the risk of harm, enhance the psychological benefits of the intervention and promote behaviour change beyond the research study. Here, we describe the theoretical underpinning and behaviour change strategies used and report 0- to 12-week changes in motivation (diet- and exercise-related), perceived competence (diet- and exercise-related) and physical self-perceptions (including global self-worth). We hypothesised that both intervention groups (RDa and LDa) would see an improvement in psychological outcomes, whilst the control group would not change.

Methods

Study design

This paper reports secondary outcomes from the IDEAL (Improving Diet, Exercise and Lifestyle) for Adolescents study (Calleja et al., 2020; Josse et al., 2020), which was a 12-week randomised controlled trial run at Brock University with a parallel three-group design (1. RDa, 2. LDa, 3. no-intervention control). Primary outcome data (Calleja et al., 2020) showed significant improvements in body composition in the RDa group compared with the LDa and control groups. This paper provides an analysis of the psychological outcomes measured at 0 and 12 weeks, which have not previously been published.

Participants and recruitment

Participants were recruited between May 2016 and June 2018 through social media, local newspaper advertisements and information flyers distributed at Brock University (Ontario, Canada) and community, education and health venues in the Niagara region. To be eligible, participants had to be female, aged 10–18 years, menarcheal, have overweight or obesity (BMI ≥85th percentile according to the World Health Organisation growth charts (Canadian Paediatric Society, 2010)), be low dairy consumers (consuming 0–2 servings/day of dairy) and report low physical activity levels (no more than 2x/week) at baseline. After collecting written informed assent (young people) and consent (parents/guardians), participants were stratified by BMI (overweight or obese) and randomised to one of the three conditions (RDa; LDa; Control) using an unblocked random allocation ratio of 2:2:1. The study was approved by the Brock University Biosciences Research Ethics Board [REB 14–284] and was registered at clinicaltrials.gov [NCT02581813].

Interventions

Dietary counselling

One-to-one dietary counselling (1-h session) was provided to participants in both intervention groups (RDa and LDa) by a registered dietitian in weeks 0, 2, 4, 8 and 12. Sessions took place at Brock University and participants were counselled to adopt a healthy, nutrient-dense diet that met their energy requirements based on age, height and weight. Participants in the RDa group were provided with and asked to consume four servings/day of dairy as recommended in Canada's Food Guide, 2007 (Health Canada, 2011), whereas participants in the LDa group were asked to maintain their habitually low dairy consumption.

Exercise training

Participants in both intervention groups (RDa and LDa) attended three exercise sessions per week for 12-weeks at Brock University (either individually or in groups of 2–3, depending on participant preference). Sessions lasted 60–90 minutes and included a combination of aerobic and

resistance exercises. In addition, participants were provided with a Fitbit Zip™ and encouraged to increase their daily steps outside the structured exercise programme (particularly on "non-exercise" days).

Participants in the no-intervention control group did not receive either the dietary counselling or the exercise training.

Theoretical underpinning

In an effort to promote positive engagement with healthy eating and exercise, intervention delivery (for both RDa and LDa conditions) was underpinned by SDT (Ryan & Deci, 2000, 2017). SDT proposes that motivation exists on a continuum ranging from amotivation (no perceived reason to perform the behaviour), through controlled motivation (perceived pressure or coercion to perform the behaviour) to autonomous motivation (internal reasons or volitional desires to perform the behaviour). Extensive research shows autonomous motivation to be important for behavioural persistence and psychological wellbeing (Ryan & Deci, 2017; Teixeira et al., 2012), with a recent meta-analysis confirming the positive effects of SDT-based health behaviour interventions on motivation, behaviour and health outcomes (Ntoumanis et al., 2021). Such interventions focus on fostering autonomous motivation through the use of strategies to support participants' basic psychological needs for autonomy (perceived volition and choice), competence (perceived ability to meet challenges) and relatedness (perceived connection with others) (Teixeira et al., 2020). Prior to the start of the intervention, the registered dietitian and lead exercise instructor [AM] were trained in "needs-supportive delivery" by a registered Sport and Exercise Psychologist [PW]. Training focused on strategies for supporting participants' basic psychological needs throughout the dietary counselling sessions and exercise training and was delivered via remote video conference, a face-to-face visit and written resources (which included worksheets to facilitate use of the strategies – see supplementary file 1). Table 1 summarises the strategies incorporated within the 12-week IDEAL intervention to support participants' autonomy, competence and relatedness, which specifically aimed to promote autonomous motivation for healthy eating and exercise.

Measures

Treatment self-regulation questionnaire (TSRQ)

The TSRQ was originally developed by Ryan and Connell (1989), and is available to download from the Center for Self-Determination Theory, 2020. Two versions of the 15-item TSRQ were used to measure a) motivation for healthy eating (TSRQ-diet) and b) motivation for exercise (TSRQ-exercise). The TSRQ has been validated across a range of health behaviours (Levesque et al., 2007) by altering the initial stem and item wording as appropriate. For the TSRQ-diet we used the stem "The reason I would eat a healthy diet is . . . ". For TSRQ-exercise we used the stem,"The reason I would exercise regularly is . . .". The TSRQ includes subscales for amotivation (three items – e.g., "I don't really know why"), controlled motivation (six items – e.g., "because I want others to approve of me") and autonomous motivation (six items – e.g., "because it is consistent with my life goals") and has previously been used to measure changes in self-regulation in adolescents (e.g., Husted et al., 2014). Items were scored on a Likert scale of 1 (not at all true) to 7 (very true) and the mean of each subscale calculated to provide an overall score for amotivation, controlled motivation and autonomous motivation, respectively. For the autonomous and controlled motivation subscales, Cronbach's *a* ranged from 0.83 to 0.92. For the amotivation subscale, Cronbach's *a* was very low for the baseline measures (0.14 for exercise and 0.40 for diet) and acceptable at 12 weeks (0.63 and 0.62, respectively). These low levels were potentially due to the small number of items in the amotivation scale (n = 3).

Perceived competence scale (PCS)

The PCS was originally employed by Williams et al. (1998), and is available to download from the Center for Self-Determination Theory, 2020. Two versions of the 4-item PCS were used to assess participants' confidence that they could a) maintain a healthy diet (PCS-diet) and b) exercise regularly (PCS-exercise). The PCS can be applied to different health behaviours by amending the wording of each item to reflect the relevant behaviour (e.g., Item 1 on the PCS-diet read,"I feel confident in my ability to maintain a healthy diet", whereas item 1 on the PCS-exercise read,"I feel confident in my ability to exercise regularly"). Each item was scored on a Likert scale of 1 (not at all true) to 7 (very true) and the mean of the four items calculated to provide an overall score. The PCS has previously been used to measure perceived competence for exercising regularly in adolescents with obesity, yielding internal consistency scores of 0.74 to 0.84 (Wagener et al., 2012). Cronbach's *a* in the current study ranged from 0.90 to 0.94.

Children and youth physical self-perception profile (CY-PSPP)

Four subscales of the 36-item CY-PSPP (Eklund et al., 1997) were used to measure global self-worth (six items), physical self-worth (six items), body satisfaction (six items) and perceived physical conditioning (six items); yielding a questionnaire of 24 items. The PSPP uses a "structured alternative format" whereby participants are presented with two types of "kids" (e.g., "some kids are often unhappy with themselves"; "other kids are pretty pleased with themselves"). Participants are asked to choose which type of child they are most like before deciding whether this is "sort of true" or "really true" for them. Due to the age of the participants in this study, we amended the word "kids" to "girls" throughout the questionnaire. Each item was scored on a scale of 1 (most negative self-evaluation) to 4 (most positive self-evaluation) and the mean of each subscale calculated to provide a score for global self-worth, physical self-worth, body satisfaction and physical conditioning, respectively. Cronbach's *a* ranged from 0.76 to 0.93.

Data analysis

Data were analysed using SPSS Statistics for Windows (Version 26.0, Armonk, NY: IBM Corp). One-way ANCOVAs were conducted using 0- to 12-week change scores as the dependent variable and baseline scores as the covariate (followed up with pairwise comparisons corrected for bias using 1000 bootstrap

Table 1. Strategies used to support participants' basic psychological needs during the IDEAL intervention.

Strategy	Psychological need/s*	Alignment with Teixeira et al. (2020) MBCT/s
Coming from the participants' perspective (e.g., open questions, active listening, empathy)	Autonomy, Relatedness	MBCT1: Elicit perspectives on condition or behaviour MBCT8: Acknowledge and respect perspectives and feelings MBCT12: Use empathic listening
Provide opportunities to make choices, and encourage participants to "take ownership" of their diet and exercise behaviours	Autonomy	MBCT6: Provide choice
Provide a meaningful rationale when making suggestions	Autonomy	MBCT5: Provide a meaningful rationale
Work together with participants to set specific goals related to their diet and exercise behaviours	Autonomy, Competence	MBCT6: Provide choice MBCT19: Help develop a clear and concrete plan of action
Encourage participants to self-monitor their exercise and dietary intake (including provision of a Fitbit Zip™ to support step goals and self-monitoring)	Competence	MBCT20: Promote self-monitoring
Provide specific, informative and non-judgemental feedback	Competence	MBCT18: Offer constructive, clear and relevant feedback
Tailor exercise sessions to individual abilities, with opportunities for progression	Competence	MBCT17: Assist in setting optimal challenge
Support participants to identify barriers and develop coping plans for overcoming these	Competence	MBCT15: Address obstacles for change
Adopt a friendly, caring manner and show interest in participants	Relatedness	MBCT11: Demonstrate/ show interest in the person
Continuity of deliverers to build rapport (e.g., each participant was paired with a volunteer student exercise trainer, who supported them throughout)	Relatedness	MBCT11: Demonstrate/ show interest in the person
Small group exercise sessions (2–3 participants) to enable interaction between participants	Relatedness	MBCT14: Prompt identification and seek available social support
Step-count challenges with friends and family members	Relatedness	MBCT14: Prompt identification and seek available social support

MBCT = Motivation and behaviour change techniques; *It is acknowledged that some strategies may support more than one psychological need. The most clearly aligned need/s are listed here.

samples). Since change scores are comparable with post-intervention scores in terms of precision and power (O'Connell et al., 2017), presentation of adjusted mean change scores was considered the most meaningful output with respect to the research objectives. Prior to the analysis, normality of the change score distribution was confirmed via Q–Q plots and Kolmogorov–Smirnov tests. The assumptions of independence of covariate and treatment effect (ANOVA) and homogeneity of regression slopes (ANCOVA) were met for all variables, with the exception of global self-worth where there was a marginally significant interaction effect between baseline scores and treatment condition (with 0–12 week change as the dependent variable, $p = 0.043$). The assumption of homogeneity of variance was met for all variables except controlled motivation for diet (Levene's test, $p = 0.033$). Although change scores were normal, several variables were not normally distributed at either 0 or 12 weeks therefore medians and interquartile ranges are used to report descriptive statistics. Partial eta squared (η_p^2) values were used to estimate the effect sizes for ANCOVA data (small ≥0.01, medium ≥0.09, large ≥0.25), Cohen's *d* for significant pairwise comparisons (small ≥0.2, medium ≥0.5, large ≥0.8) and Pearson's correlation coefficients (*r*) for significant within-groups effects (small ≥0.1, medium ≥0.3, large ≥0.5). Estimates of effect size magnitude were drawn from MRC Cognition and Brain Sciences Unit (2020) guidance. Significance was set at $p < 0.05$.

Results

Baseline characteristics

Sixty-three participants (mean age 14.8 ± 2.3 years) were recruited and randomised (RDa n = 24; LDa n = 25; Control n = 14). All participants randomised to an intervention condition provided complete psychological data at 0 and 12 weeks, with the exception of 2 participants in the LDa group who were randomised but did not start the intervention (reasons unrelated to the study). Only seven participants from the control group provided 12-week measures; therefore, the complete case analysis included 54 participants (RDa n = 24; LDa n = 23; Control n = 7). Mean baseline BMI (kg/m^2) was 29.2 ± 5.1 and differed significantly between groups (RDa 30.2 ± 5.2; LDa 29.6 ± 5.0; Control 24.6 ± 2.5; $p = 0.034$).

Diet-related motivation and perceived competence

Table 2 shows the baseline (0 weeks), post-intervention (12 weeks) and adjusted change scores for healthy eating motivation and perceived competence for maintaining a healthy diet. At both time-points, all three groups had higher median scores for autonomous motivation and perceived competence than for controlled motivation and amotivation, indicating a positive motivational profile. After adjusting for baseline scores, there were no between-group differences in 0- to 12-week changes for healthy eating motivation or perceived competence for maintaining a healthy diet. The LDa group did, however, show a significant decrease in amotivation ($p = 0.03$, $r = -0.32$, medium effect), with the RDa group showing a comparable decrease that approached significance ($p = 0.07$, $r = -0.26$, small effect). The RDa group (but not the LDa group) also showed a significant increase in perceived competence for maintaining a healthy diet ($p = 0.02$, $r = 0.33$, medium effect).

Exercise-related motivation and perceived competence

Table 3 shows the baseline (0 weeks), post-intervention (12 weeks) and adjusted change scores for exercise motivation and perceived competence for exercising regularly. All three groups displayed positive motivational profiles at both baseline and post-intervention, with higher median scores for

Table 2. Diet-related Motivation and Perceived Competence Pre- and Post-IDEAL Intervention (RDa n = 24; LDa n = 23; Control n = 7).

			0 weeks (Med ±IQR)	12 weeks (Med ±IQR)	0–12 week adjusted Mean change (95% CI)[a]	Within-group p[b]	Between-group p[a]	Partial η^2
Motivation for healthy eating	Amotivation	RDa	2.7 ± 2.1	1.7 ± 2.3	−0.4 (−0.9 to 0.0)	0.07	0.43	0.03
		LDa	2.3 ± 1.3	2.0 ± 1.0	−0.5 (−0.9 to −0.2)	**0.03**		
		Control	2.7 ± 2.0	2.7 ± 2.7	0.0 (−0.9 to 0.9)	1.00		
	Controlled	RDa	3.6 ± 2.2	2.8 ± 2.3	−0.3 (−0.7 to 0.2)	0.40	0.32	0.04
		LDa	3.8 ± 2.2	3.5 ± 1.3	−0.1 (−0.4 to 0.2)	0.78		
		Control	3.2 ± 1.2	3.8 ± 2.8	0.4 (−0.7 to 1.4)	0.40		
	Autonomous	RDa	5.4 ± 1.8	6.0 ± 1.3	0.4 (0.0 to 0.7)	0.10	0.70	0.01
		LDa	5.5 ± 1.7	6.2 ± 1.3	0.2 (−0.2 to 0.6)	0.18		
		Control	5.0 ± 2.8	5.5 ± 2.0	0.1 (−0.7 to 0.6)	0.46		
Perceived competence for maintaining a healthy diet		RDa	4.8 ± 2.0	5.6 ± 2.0	0.6 (0.1 to 1.1)	**0.02**	0.67	0.02
		LDa	5.5 ± 2.0	5.5 ± 3.0	0.3 (−0.3 to 0.9)	0.76		
		Control	4.8 ± 4.0	5.5 ± 3.0	0.3 (−0.3 to 0.9)	0.23		

Med = Median; IQR = Interquartile range; CI = confidence interval based on 1000 bootstrap samples; p < 0.05 highlighted in bold; [a]ANCOVA, adjusted for baseline; [b]Wilcoxon signed-rank test. Effect size estimates relate to the main ANCOVA, others are reported in text.

Table 3. Exercise-related Motivation and Perceived Competence Pre- and Post-IDEAL Intervention (RDa n = 24; LDa n = 23; Control n = 7).

			0 weeks (Med ±IQR)	12 weeks (Med ±IQR)	0–12 week adjusted Mean change (95% CI)[a]	Within-group p[b]	Between-group p[a]	Partial η^2
Exercise motivation	Amotivation	RDa	2.5 ± 1.7	2.0 ± 1.8	−0.4 (−0.9 to 0.2)	0.20	0.84	0.01
		LDa	2.7 ± 1.3	2.3 ± 0.7	−0.4 (−0.7 to −0.1)	0.07		
		Control	3.7 ± 1.3	2.0 ± 2.0	−0.7 (−1.5 to 0.2)	0.08		
	Controlled	RDa	3.2 ± 2.2	3.0 ± 2.1	0.0 (−0.4 to 0.5)	0.78	0.13	0.08
		LDa	3.0 ± 1.3	3.3 ± 1.3	0.3 (−0.1 to 0.6)	0.46		
		Control	2.5 ± 2.0	3.2 ± 2.3	0.9 (−0.3 to 2.0)	0.08		
	Autonomous	RDa	5.5 ± 2.3	5.8 ± 1.8	0.3 (−0.1 to 0.7)	0.17	1.00	0.00
		LDa	5.5 ± 1.5	6.0 ± 1.5	0.3 (0.0 to 0.6)	0.10		
		Control	4.8 ± 2.7	5.8 ± 2.8	0.3 (−0.2 to 0.8)	**0.03**		
Perceived competence for exercising regularly		RDa	4.6 ± 2.2	6.0 ± 1.5	0.9 (0.5 to 1.3)	**0.001**	0.17	0.07
		LDa	5.3 ± 2.0	5.8 ± 1.5	0.7 (0.1 to 1.2)	0.17		
		Control	4.5 ± 2.0	4.5 ± 2.0	0.1 (−0.7 to 0.9)	0.67		

Med = Median; IQR = Interquartile range; CI = confidence interval based on 1000 bootstrap samples; p < 0.05 highlighted in bold; [a]ANCOVA, adjusted for baseline; [b]Wilcoxon signed-rank test; Effect size estimates relate to the main ANCOVA, others are reported in text.

autonomous motivation and perceived competence than for controlled motivation and amotivation. After adjusting for baseline scores, there were no between-group differences in 0- to 12-week changes for exercise motivation or perceived competence for exercising regularly. The LDa and control groups did however show decreases that approached significance in amotivation (LDa p = 0.07, r = −0.27, small effect; Control p = 0.08, r = −0.48, medium effect). The control group also showed a significant increase in autonomous motivation (p = 0.03, r = 0.59, large effect) and a near-significant increase in controlled motivation (p = 0.08, r = 0.48, medium effect). As with healthy eating, the RDa group (but not the LDa group) showed a significant increase in perceived competence related to exercising regularly (p = 0.001, r = 0.48, medium effect).

Table 4. Self-perceptions Pre- and Post-IDEAL Intervention (RDa n = 24; LDa n = 23; Control n = 7).

		0 weeks (Med±IQR)	12 weeks (Med±IQR)	0–12 week adjusted Mean change (95% CI)[a]	Within-group p[b]	Between-group p[a]	Partial η^2
Global self-worth	RDa	3.0 ± 1.0	3.2 ± 1.0	0.5 (0.2 to 0.8)	**0.03**	0.33	0.04
	LDa	2.3 ± 1.0	2.8 ± 1.0	0.3 (0.0 to 0.5)	**0.007**		
	Control	3.0 ± 2.0	3.3 ± 1.0	0.2 (−0.2 to 0.6)	0.27		
Physical self-worth	RDa	2.0 ± 1.0	2.8 ± 1.0	0.7 (0.5 to 1.0)	**<0.001**	**0.001**	0.23
	LDa	2.0 ± 1.0	2.7 ± 1.0	0.4 (0.1 to 0.6)	**0.003**		
	Control	2.3 ± 1.0	2.0 ± 1.0	−0.2 (−0.5 to 0.2)	0.10		
Body satisfaction	RDa	1.6 ± 1.0	2.3 ± 1.0	0.6 (0.4 to 0.8)	**<0.001**	**0.002**	0.23
	LDa	1.7 ± 1.0	2.2 ± 2.0	0.3 (0.1 to 0.5)	**0.002**		
	Control	1.8 ± 2.0	1.7 ± 1.0	−0.2 (−0.5 to 0.1)	0.17		
Physical conditioning	RDa	2.3 ± 1.0	3.0 ± 1.0	0.7 (0.5 to 0.9)	**<0.001**	**0.002**	0.22
	LDa	2.5 ± 1.0	2.8 ± 1.0	0.4 (0.2 to 0.6)	**0.001**		
	Control	2.8 ± 1.0	2.7 ± 1.0	−0.2 (−0.5 to 0.2)	0.13		

Med = Median; IQR = Interquartile range; CI = confidence interval based on 1000 bootstrap samples; p < 0.05 highlighted in bold; [a]ANCOVA, adjusted for baseline; [b]Wilcoxon signed-rank test. Effect size estimates relate to the main ANCOVA, others are reported in text.

Self-perceptions

Table 4 shows the baseline (0 weeks), post-intervention (12 weeks) and adjusted change scores for global self-worth, physical self-worth, body satisfaction and perceived physical conditioning. At baseline, most median scores were <2.5, indicating a predominantly negative self-evaluation (particularly in the body satisfaction domain). At 12 weeks, this profile improved for the intervention groups, with significant between-group differences in adjusted mean change for physical self-worth (p = 0.001, η_p^2 = 0.23, medium effect), body satisfaction (p = 0.002, η_p^2 = 0.23, medium effect) and physical conditioning (p = 0.002, η_p^2 = 0.22, medium effect). Pairwise comparisons revealed both RDa and LDa groups showed significantly greater 0- to 12-week changes than the control group in physical self-worth (RDa p = 0.001, *d* = 1.45; LDa p = 0.01, *d* = 1.01; both large effects), body satisfaction (RDa p = 0.001, *d* = 1.50; LDa p = 0.003, *d* = 1.25; both large effects) and physical conditioning (RDa p = 0.001, *d* = 1.62; LDa p = 0.004, *d* = 1.10; both large effects). The RDa group also demonstrated significantly greater change in physical self-worth than the LDa group (p = 0.03, *d* = 0.60, medium effect). There were significant within-group increases from 0 to 12 weeks in the RDa and LDa groups for all four self-perception variables (*r* ranging from 0.31 to 0.56, medium to large effects). Adjusted mean change scores for the control group suggested a potential decline in physical self-worth, body satisfaction and physical conditioning, although this failed to reach significance (physical self-worth p = 0.10, *r* = −0.45; body satisfaction p = 0.17, *r* = −0.36; physical conditioning p = 0.13, *r* = −0.41; all medium effects).

Discussion

When designing efficacy trials for adolescent girls with overweight and obesity, it is important to mitigate the psychological risks while maximising the potential benefits of participation. In this paper, we report psychological outcomes following the delivery of a theory-based behavioural support programme within the IDEAL for Adolescents study. Contrary to the hypothesis, we found no between-group differences in 0- to 12-week changes in either motivation or perceived competence for healthy eating or exercise, with all three groups (RDa, LDa and control) reporting high quality of motivation and relatively high perceived competence throughout. We did, however, find significant between-group differences in self-perceptions, with both intervention groups demonstrating improved physical self-worth, body satisfaction and perceived physical conditioning at 12 weeks compared with the control group (who demonstrated no change).

The SDT strategies used within the IDEAL intervention were in line with delivery behaviours perceived to be of value by adolescents within weight management settings (Jones et al., 2018; Yerges et al., 2021). Specifically, female adolescents have expressed the importance of professionals showing they care about the person behind the weight, providing specific and clear information and allowing adolescents autonomy to take responsibility for their own lifestyle change (Yerges et al., 2021). Whilst there were no significant improvements in quality of motivation in the current study, it is noteworthy that all three groups were predominantly autonomously motivated at baseline. The adolescents in our study self-selected to take part, and it is possible they were more autonomously motivated than other female adolescents with overweight and obesity. Indeed, it is notable that the high levels of autonomous motivation we observed (in this Canadian group of female adolescents with overweight and obesity) were similar to baseline levels of autonomous motivation in a mixed-gender sample of lower secondary school pupils in Finland (Schneider et al., 2020). Thus, the needs-supportive strategies within the IDEAL intervention may have served to "preserve" existing autonomous motivation rather than foster new motivation. For already motivated participants, it is possible that placing contingencies on the behaviour may diminish autonomous motivation (Ryan & Deci, 2017), i.e., participants may feel controlled because of the *requirement* to eat healthily and exercise. The observed preservation of autonomous motivation is therefore encouraging and suggests that, even within laboratory-based efficacy trials, delivery in a needs-supportive manner may be protective against such concerns.

As with motivation, perceived competence was relatively high in our participants at baseline (medians from 4.5 to 5.5 on a 7-point scale) albeit slightly lower than a mixed-gender group of adolescents with obesity in the USA (mean 5.7, Wagener et al., 2012). Perceived competence remained high post-intervention, but only the RDa group saw a significant increase (for both diet and exercise) from 0 to 12 weeks. It is not clear why the RDa group had a more positive response than the LDa group although two explanations are worthy of consideration. First, the RDa group received a "prescription" for a recommended amount of dairy (which included provision of the necessary foods to achieve this), whereas the LDa group were asked to continue with their current (low) dairy intake. It is possible the clarity of the prescription, coupled with the provision of food, removed some of the barriers to lifestyle change (i.e. knowledge and food availability), which may have increased participants' beliefs that they were able to follow the recommended diet. Second, the RDa group experienced more favourable increases in body composition (Calleja et al., 2020) and had a slightly higher adherence to the exercise sessions than the LDa group (86% vs 79%, reported in Calleja et al., 2020). As both outcome expectations and mastery experiences are important influences on self-efficacy (Bandura, 1997), it is plausible that the more success participants felt they were achieving (through managing to attend sessions and through seeing changes in their body), the more they believed in their ability to adhere to a healthy lifestyle. On the same token, it is noteworthy that exercise adherence (and perceived competence) was relatively high in both intervention groups; therefore, perceived competence may have been lower in a study with poor adherence and less favourable results. Thus, it is plausible that the high focus on adherence to protocols within efficacy trials may be beneficial in providing adolescents with an opportunity to succeed, which in turn may enhance their perceived competence for adhering to healthy lifestyles in the future.

Given the often-reported low self-esteem of adolescents with obesity (Griffiths et al., 2010), and heightened self-

consciousness in adolescent girls in particular (Cowley et al., 2021), the positive effects we observed on physical self-perceptions are encouraging. We saw significant increases in physical self-worth, perceived physical conditioning and body satisfaction in the intervention groups, while the control group appeared to decrease in these domains (medium size effects albeit non-significant due to the small sample size). It has been suggested that supportive factors within the environment might contribute to improvements in physical self-perceptions during weight management interventions (Hill, 2017), such as being in the same situation as others with obesity, making new friends and raised perceptions of competence through experiences of success (all of which were fostered through the needs-supportive approach within the IDEAL intervention).

It is noteworthy that at baseline the median global self-worth scores within our sample were relatively high in the RDa and control groups (a score >2.5 indicates a profile that is more positive than negative), supporting Hill's (2017) recent observation that living with obesity does not always indicate a low self-esteem (although the CY-PSPP uses the term "self-worth" the items are aligned with the self-esteem construct). In the physical domain, however, baseline scores indicated predominantly negative self-perceptions (median scores mostly <2.5). This was particularly notable in the body satisfaction domain, where baseline scores were low (median 1.6–1.8) and, despite significant intervention effects, remained predominantly negative at 12 weeks (RDa 2.2, LDa 2.3). Youth with obesity often have poor perceptions of physical appearance (Hill, 2017) and in Gow et al.'s (2020) recent meta-analysis of 40 studies they found the effects of weight management interventions on body image were small to moderate. As such, weight management interventions may lay the foundations for psychological change, but when baseline scores are low (as in body satisfaction in the current study) longer-term support may be required for adolescents with obesity to reach a point where they view their body positively. Nonetheless, it is encouraging that when increases in body image do occur, they appear to be maintained at long-term follow-up (ranging from 14 weeks to 6 years after baseline, Gow et al., 2020).

It is important also to consider the psychological effects of trial participation for the control group, only 50% of whom completed the current study. Whilst the participants who completed increased in exercise motivation (albeit in both controlled and autonomous forms) and maintained a predominantly positive global self-worth, four of seven participants showed decreased physical self-perceptions at 12 weeks (two remained the same, and one increased). Similar declines were observed in a control group of low-active adolescent boys within an obesity prevention trial (Morgan et al., 2012), which raises the question whether these were natural declines occurring due to the challenges of adolescence or whether participation in the control arms of obesity-related trials might negatively affect physical self-perceptions (either through a heightened focus on weight or through self-reflection prompted by questionnaire completion). It is challenging to investigate experimentally whether completion of self-perception questionnaires alone could have a negative impact on adolescents who already have low self-perceptions, due to the mutually conflicting nature of the question (i.e., it is not possible to compare responses over time with a control group who did not complete any measures). Whilst historical research with adults suggests completion of multiple psychological questionnaires can reduce subsequent ratings of self-esteem (Brody et al., 1990), more recent research with adolescents (Langhinrichsen-Rohling et al., 2006) and college students (Whitlock et al., 2013) suggests psychological questionnaire completion rarely has negative effects (and may even be beneficial). Although sensitive questions may be upsetting to those with a history of psychological distress, the process of completing the questionnaire may also prompt positive reflection or behavioural intentions (e.g., to seek therapy, Whitlock et al., 2013). To our knowledge, however, no such research has been conducted with adolescents in a weight management context. The use of qualitative techniques such as "think aloud" (e.g., Nehlin et al., 2018) and semi-structured interviews may improve our understanding of the impact of self-perception questionnaire completion on adolescents with obesity.

Methodological considerations

This paper reported the psychological outcomes of a laboratory-based efficacy trial for adolescent girls with overweight and obesity. In doing so, we demonstrated how a theory-based psychological approach can be integrated into a diet and exercise intervention, and opened a vital discussion about the principles of non-maleficence and beneficence in the adolescent weight management context. The study is not, however, without limitations. First, it is important to interpret the within-subjects effect sizes with caution, as within-subjects effect sizes are often inflated (and in this case were derived from a non-parametric test). We were also mindful that the study was powered for the primary outcome (body composition) and consequently it is likely the psychological measures were underpowered. This is particularly the case for the control group, where only 50% participants (n = 7) provided data for the complete case analysis (this group did, however, have a similar psychological profile to those who dropped out, with no significant differences in baseline scores). Although the control group had a lower BMI at baseline than the RDa and LDa groups, their psychological profiles were comparable and as the control group had limited contact with other participants, we believe it unlikely differences in weight status impacted changes in self-perceptions.

As this was an analysis of secondary measures, it was not possible to include an active comparison group (i.e., those who received the diet and exercise intervention without the needs-supportive delivery component). We also did not collect fidelity data and it is not known to what extent the needs-supportive strategies were put into practice by deliverers. We cannot therefore draw conclusions about the specific impact of the behaviour change component, and acknowledge the possibility that positive psychological changes might have occurred through dietary counselling and exercise alone (or through environmental factors associated with weight management support, as highlighted by Hill, 2017). Further research is needed to investigate the psychological effects of laboratory-based diet and/or

exercise trials that do not contain a behaviour change component (and compare these with theory-based behaviour change interventions). Finally, since the primary aim of the trial was to compare the impact of the RDa and LDa conditions on body composition within the 12-week intervention, we were not able to evaluate long-term psychological and behavioural changes.

Implications for trial design

Evidence suggests multicomponent weight management interventions have positive psychological benefits for adolescents with obesity (Gow et al., 2020), but it is important these are carried over into laboratory-based settings. To adhere to the principle of non-maleficence, non-psychology researchers working in the field of adolescent obesity (e.g., exercise scientists, dietitians/nutritionists, medical researchers) are encouraged to include psychologists within the multi-disciplinary team and to include psychological measures as secondary outcomes. At a minimum, these outcomes should include physical self-perceptions and self-esteem, with other potential measures including motivation, perceived competence, eating behaviour, anxiety and depression.

Sometimes, however, consideration of non-maleficence may not be enough. Health researchers also have an ethical responsibility to promote positive wellbeing in adolescents with obesity and support them to make beneficial lifestyle changes. While we recognise it is not always possible to add a comprehensive behaviour change component (due to lack of psychological expertise or because doing so will contaminate the primary research question), researchers are encouraged to design study protocols that foster positive psychological wellbeing for those taking part (both intervention and control participants). The current trial provided examples of strategies that might achieve this, such as group exercise sessions to promote social support (Jones et al., 2018), "gentle" communication when discussing weight (Yerges et al., 2021), and providing adolescents with the opportunity to make choices about their diet and exercise behaviours. Given the poor body image among adolescent girls with overweight and obesity, researchers might also consider signposting participants to online mental health resources for further support (e.g., https://youngminds.org.uk/).

Conclusion

When working with adolescents with overweight and obesity, researchers need to be mindful of their ethical responsibility to first "do no harm" and second "do good". In this multidisciplinary study, we observed favourable psychological outcomes from an SDT-informed diet and exercise intervention for adolescent girls with overweight and obesity. Whilst we cannot draw conclusions about the extent to which the behaviour change component was responsible for the observed changes, the study does demonstrate how theory can be applied to reduce psychological risk and to promote psychological benefits within a laboratory-based efficacy trial. To this end, researchers are encouraged to consider psychological factors when designing efficacy trials for adolescents by, at a minimum, including measures of psychological outcomes and, where possible, implementing delivery strategies to ensure a safe psychological environment and to promote sustainable behaviour change.

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