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Title: Psychosocial Interventions in the Treatment of Severe Adolescent Obesity: The SHINE Programme

Authors:

James Nobles¹

Duncan Radley¹ (M.Sc., Ph.D.)

Paul Dimitri² (MBChB, FRCPC, Ph.D.)

Kath Sharman³ (RGN, M.A.)

Affiliations:

¹ Carnegie Faculty, Leeds Beckett University, Headingley Campus, Leeds, UK. *Email:*

j.d.nobles@leedsbeckett.ac.uk and duncan.radley@leedsbeckett.ac.uk

² The Department of Paediatric Endocrinology, The Academic Unit of Child Health, Sheffield

Children's Hospital, Western Bank, Sheffield, UK. *Email:* paul.dimitri@sch.nhs.uk

³ SHINE Health Academy Ltd., 300 Prince of Wales Road, Sheffield, UK. *Email:*

kath@shinehealthacademy.org.uk

Corresponding Address and Email Address: Churchwood 105, Leeds Beckett University, Headingley Campus, Leeds, UK. *Email:* j.d.nobles@leedsbeckett.ac.uk **Phone:** 0113 812 9110

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Disclosure Statement: JN and DR are independent to the SHINE programme and do not hold any conflicts of interest. KS is the Managing Director of SHINE Health Academy. PD, and the Sheffield Children's Hospital, accept referrals from SHINE when more specialist services are required (i.e. Tier 4, bariatric surgery or pharmacotherapy). SHINE also accept referrals from Sheffield Children's Hospital. Leeds Beckett University completed the evaluation of the data, and consulted with KS and PD in the development of the article.

Abbreviations: SHINE: Self Help, Independence, Nutritional and Exercise, PSI: Psychosocial Intervention, WMP: Weight Management Programme, BMI: Body Mass Index, WC: Waist Circumference, SDS: Standardised value (e.g. BMI SDS), UK: United Kingdom, LOCF: Last Observation Carried Forward.

Abstract

Purpose: Psychosocial Interventions (PSI) are characterised by three phases: 1) an initial in-depth assessment, 2) an intensive multifaceted intervention to stem a condition, and 3) an extensive maintenance programme. PSIs are often used for treatment of mental health conditions, however applicability in the treatment of adolescent obesity is unknown. This paper sought to evaluate the service-level outcomes of a PSI for young people (aged 10-17) with severe obesity.

Methods: A retrospective evaluation of participants attending the SHINE programme between 2011-2016 ($n = 435$; Age: 13.1 ± 2.1 years, Male: 51%, White: 87.4%, BMI: 33.5 ± 7.5 kg/m², BMI SDS: 3.1 ± 0.5 units). Anthropometric measurements (BMI and WC) were collected at baseline, 3-, 6-, 9-, and 12-months. Psychosocial measures (anxiety, depression, and self-esteem) were collected at baseline and 3 months. Participant retention was also assessed.

Results: After 3 months, 95% of participants remained with a mean BMI SDS reduction of 0.19 units (95% CI: 0.17, 0.21). Anxiety, depression, and self-esteem improved by 50%, 54% and 38% respectively. BMI SDS reductions of 0.29, 0.35 and 0.41 were found at 6-, 9-, and 12- months. Fifty-four percent of participants chose to attend the final intervention phase. A higher baseline BMI SDS and a greater reduction in BMI SDS predicted final intervention phase attendance.

Conclusion: The SHINE PSI demonstrated positive mean reductions in all measurements across all time points. In contrast to other community-based weight management services, these results suggest the utility of, and further exploration of, PSIs in the treatment of severe adolescent obesity.

Key Words: Psychosocial Intervention, Weight Management Programme, Service Evaluation, Retention, Severe Obesity, Adolescent.

Implications and Contribution

SHINE - a community-based, Tier 3 weight management programme - presents a novel and potentially effective means of treating obesity in adolescents. SHINE focuses on holistic health improvement (social relationships, stress management and self-esteem) alongside dietary and physical activity behaviour change. Results show significant improvements in both psychosocial and anthropometric measurements.

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Original Article

The prevalence of childhood obesity has increased rapidly throughout the last three decades in the United Kingdom (UK). The Health Survey for England indicates that 35.2% of adolescents alone, aged 11-15 years, are overweight (16.4%) or obese (18.7%) [1], with previous studies suggesting that 22-90% will be obese in adulthood if intervention is not sought [2]. Factors shown to mediate obesity include low levels of physical activity, a more sedentary lifestyle and poor dietary behaviours. Psychosocial factors, such as low self-esteem, depression, anxiety and poor social relationships, are also known to correlate with obesity [3].

The UK currently implements a four-tiered approach to preventing and treating obesity, the Obesity Care Pathway [4]. The first tier of the pathway focuses on the prevention of overweight and obesity, primarily through marketing campaigns, awareness raising and knowledge building (e.g. Change4Life). Tiers 2-4 however are dedicated to obesity treatment. The pathway stipulates that more specialist treatment is provided for children with a greater degree of obesity, insofar that Tier 2 provides generic weight management advice, Tier 3 provides specialist intervention from a multidisciplinary team and Tier 4 offers intensive treatment, pharmacotherapy and bariatric surgery [4]. This pathway is primarily used in the management of adult obesity, and application in the management of severe obesity in young people (particularly Tiers 3 & 4) is limited. Recent data suggests that approximately 56% of local authorities have a Tier 2 service, and only 9% have a Tier 3 service for children and young people [5].

Traditional community-based weight management programmes (WMP) for young people (often at the Tier 2 level) predominantly focus on healthy eating, increasing exercise and behaviour modification [6; 7]. Such programmes usually last between 3 to 6 months [7]. Programmes adopting this approach usually exhibit modest improvements in Body Mass Index (BMI) during WMP delivery periods, but studies monitoring long-term, post WMP effects, weight regain is frequently observed

[7]. Furthermore, traditional programmes will seldom address the psychosocial complexities presented by many obese adolescents [8].

SHINE (Self Help, Independence, Nutrition and Exercise) - a Tier 3, not-for-profit, community-based WMP in Sheffield - was founded in 2003 to help severely obese adolescents (aged 10-17 years, standardised BMI [BMI SDS] $\geq 99.6^{\text{th}}$ centile). SHINE recognises the complicated aetiology of obesity, and rather than solely improving dietary and physical activity habits, the programme targets psychosocial areas often associated with obesity: low self-confidence, stress, depression, and poor social relationships [3; 8]. The programme offers a psychosocial intervention (PSI); defined as treating or preventing a condition using educational, behavioural and/or cognitive approaches [9]. PSIs are conventionally administered in the treatment of mental health conditions, cancers, and HIV/AIDS [10; 11]; conditions which each share commonalities with obesity: chronic nature, negative psychosocial consequences and episodic relapses [12; 13]. SHINE considers the wider implications associated with obesity and therefore delivers a long-term programme to prevent weight deterioration and promote salubrious habit (re)formation.

PSIs are characterised by three distinct phases. Phase 1 is an acute stage where participants are assessed and signposted to the most appropriate method of treatment using a stepped-care approach [14]. Phase 2 comprises the active stage of the intervention; participants undertake an intensive, educational programme with the aim of stemming the condition (e.g. weight gain). The final phase, known as the maintenance stage, aims to educate participants how to sustain the behavioural changes made in Phase 2. SHINE supports and educates the young person and their family in long-term, sustainable management of body weight.

To the extent of our knowledge, SHINE is the first WMP to adopt the PSI approach when providing a Tier 3 service. This paper examines the anthropometric, psychosocial and retention outcomes of the SHINE PSI. As a secondary aim, this paper also investigates the variables predictive of initiating the programme, and those predictive of continuing attendance into Phase 3 of the programme.

Methods

Study Design and Setting

A retrospective service evaluation of the SHINE programme was undertaken. No control or comparator group data was available. Eligible participants were either severely obese (BMI SDS ≥ 2.67 units [99.6th centile]) or obese (BMI SDS ≥ 2.00 units [98th centile]) with associated co-morbidities (e.g. Hypertension, Depression, Type 2 Diabetes) [15; 16]. Phase 1 to Phase 3 lasts 15 months, but families may use the service *ad hoc* until the child's 18th birthday. Families pay a weekly attendance fee (£5/\$8). The SHINE programme consists of three phases - aligned to the PSI approach. A standardised [17], comprehensive overview of the SHINE programme is available in a supplement.

Data

SHINE provided participant data from September 2011 to March 2016 ($n = 513$). Participants with a BMI SDS $< 98^{\text{th}}$ centile were excluded from the analyses ($n = 34$), as were those who attended a pilot programme ($n = 42$), or with erroneous data ($n = 2$), resulting in a final sample of 435 participants.

Parental consent was previously obtained by SHINE. Ethical clearance for secondary data analysis was provided by Leeds Beckett University Research Ethics Committee (*ref*: 13048).

Participant Entry Characteristics

Participant information included gender, age (years and classification [< 13.5 years and > 13.5 years]), ethnicity (white or non-white), presence of a diagnosed learning disability (ADHD, Asperger's Syndrome, or Down's Syndrome), and referral pathway (self-referral or non-self-referral [Schools, Physicians, Multi Agency Support Teams, Child and Adolescent Mental Health Services, and Social Services]).

Anthropometric Measurements

BMI (kg/m^2) and Waist Circumference (WC [cm]) were standardised for age using the UK growth reference data [15; 17]. Clinical cut-offs were applied to BMI SDS to provide weight classifications (obese [2.00 to 2.66 units, 98th to 99.5th centile], severely obese [2.67 to 3.49 units, 99.6th to 99.97th centile]) [15]. An additional classification - very severely obese - was categorised as a standardised value exceeding 3.50 units, equivalent to the 99.98th centile [18]. All measurements were completed by the same senior obesity specialist and in accordance with standardised protocols [15; 17]. Data were collected at baseline, 3-, 6-, 9-, and 12- months, conditional on participant attendance.

Psychological Measurements

Self-esteem, anxiety and depression were assessed through the Rosenberg Self-Esteem Scale [19] (higher scores represent greater self-esteem, range 0-30) and the Hospital Anxiety and Depression Scale [20] (higher scores represent higher anxiety/depression, range 0-21) respectively. These measurements were recorded at baseline and 3 months. Both measures are validated for adolescent cohorts [19; 21]. Measurements were not collected beyond 3 months as to reduce participant monitoring burden. Sample (n) values are fewer for psychosocial measures as they were only collected from late 2012 onwards.

Participant Engagement

The presence of anthropometric data at each time point (baseline, 3-, 6-, 9-, and 12- months) were used to identify participants engaged in the programme (sessional attendance data were not available). Participants were termed *non-initiators* if they signed on to the programme and did not attend a session, therefore providing no anthropometric data. Those with anthropometric data until 3 months only were classified as *Phase 2 completers*, and those with data beyond 3 months classified as *Phase 3 attenders*.

Statistical Analysis

Repeated-measures ANOVAs were used to evaluate change in anthropometry (BMI, BMI SDS, WC, WC SDS) between baseline and subsequent time points (3-, 6-, 9- and 12- months). Bonferroni *post-hoc* tests determined between time point differences. Additionally, Intention to Treat Analysis (Last Observation Carried Forward [LOCF]) were applied to BMI and WC (including SDS) to reduce attrition bias by forecasting future results based on the last measurement recorded [22]. Independent *t*-tests examined differences between binary groups (gender, ethnicity, and referral) and change in anthropometry at each time point. Paired samples *t*-tests determined the change in psychosocial measures from baseline to 3 months.

Frequency and percentage statistics assessed participant retention at each time point. Univariable and multivariable logistic regression models were used to examine which variables predict (1) programme initiation (start the programme) or non-initiation (do not start programme), and (2) Phase 2 completion only or Phase 3 attendance. Multivariable models were developed using a backwards removal criteria – significant variables remained at the last step of the regression.

Results

Participant Characteristics

The majority of participants commencing SHINE were white (88.2%), with a mean age of 12.9±2.0 years. Fifty-one percent were male and 27.1% had a diagnosed learning disability. Regarding BMI SDS classification: 19.0% were obese, 56.2% severely obese and 24.8% very severely obese. Table 1 details characteristics of programme initiators ($n = 347$) and non-initiators ($n = 435$).

[INSERT TABLE 1]

Phase 2 Outcomes

At 3 months, mean BMI SDS had reduced by 6.2% (BMI SDS reduction: 0.19, 95% CI: 0.17, 0.21) from baseline. Notably, 27.1% of participants improved their BMI classification (e.g. classified as severely obese at baseline and obese at 3 months). Mean change in BMI SDS amongst those improving weight classification was 0.37 units (95% CI: 0.32, 0.41).

Self-referrals had a significantly greater reduction in BMI SDS than those who did not self-refer (0.06, 95% CI: 0.02, 0.10; $p < 0.001$). Self-referrals reduced BMI SDS by 0.23 ± 0.20 units, with non-self-referrals achieving a 0.17 ± 0.18 unit reduction. No significant differences in anthropometric changes were observed by gender, age classification or ethnicity.

Psychosocial measures all significantly improved also during Phase 2. Anxiety scores ($n = 168$) decreased by 49.9% (baseline: 8.85 ± 5.32 , 3 months: 4.43 ± 4.95 , $p < 0.001$). Depression scores ($n = 168$) also reduced from 5.60 ± 5.01 units at baseline to 2.57 ± 3.91 units after 3 months ($p < 0.001$). Lastly, self-esteem scores ($n = 157$) increased significantly within the 3 months by 38.1% (baseline: 16.28 ± 7.16 , 3 months: 22.48 ± 6.71 , $p < 0.001$).

Phase 3 Outcomes

Statistically significant reductions from baseline were found at 6, 9 and 12 months for all anthropometric measures (Table 2). BMI SDS decreased by 0.29 units (95% CI: 0.29, 0.34) after 6 months ($n = 187$), 0.35 units (95% CI: 0.28, 0.43) after 9 months ($n = 143$) and 0.41 units (95% CI: 0.31, 0.51) after 12 months ($n = 107$) (Figure 1); equating to percentage reductions of 9.2%, 11.0% and 12.9% respectively. WC SDS demonstrated greater reductions than BMI SDS across all measurement points.

[INSERT TABLE 2 and FIGURE 1]

Engagement and Retention

Of the 435 participants who signed onto the programme, 20.2% ($n = 88$) did not attend the initial session (non-initiators). Three hundred and forty-seven participants consequently attended the first session. Eighteen (5.2%) participants did not complete Phase 2 of the PSI programme, leaving 329 (94.8%) participants after 3 months.

One hundred and eighty-seven participants (53.9%) opted to attend Phase 3 of the programme. After 9 months, 143 remained engaged and 107 after 12 months. Figure 2 presents participant retention throughout the first 12 months of the programme, relative to those who provided a baseline measurement ($n = 347$).

[INSERT FIGURE 2]

Programme Initiators and Programme Continuers

Model 1 examined variables predictive of programme initiation ($n = 347$) or non-initiation ($n = 88$). Self-referrers had a six times greater likelihood of initiating the programme than those from professional and school-based referrals combined (OR: 6.06, 95% CI: 3.2, 11.47). Participants with a diagnosed learning difficulty – as opposed to without - had 2.3 times greater odds of initiating the programme (OR 2.31, 95% CI: 1.21, 4.42). Age was not a significant determinant of programme initiation in the final model. Overall variance in the outcome remained largely unexplained ($R^2 = 0.12$ [Cox & Snell], 0.18 [Nagelkerke]).

Model 2 analysed variables which may be associated with completing Phase 2 only ($n = 145$) or attending the Phase 3 intervention ($n = 185$). A unit reduction in BMI SDS (in Phase 2) led to 11.2 times greater likelihood of engaging in Phase 3 (OR: 11.17, 95% CI: 2.92, 42.86). Additionally, those with higher baseline BMI were more likely to continue the programme (OR: 1.74, 95% CI: 1.11, 2.74). Again, the majority of the variance in the outcome was unexplained by these two variables ($R^2 = 0.05$ [Cox & Snell], 0.06 [Nagelkerke]). No other variables were significantly associated with this outcome.

[INSERT TABLE 3]

Discussion

Evidence relating to the evaluation of adolescent WMPs is limited, particularly when assessing those implemented within the UK [23]. Of those with published results, the programmes are often Tier 2 community-based interventions lasting between 3 and 6 months (e.g. MEND, GOALS, Families for Health). SHINE, a Tier 3 community-based WMP specifically for severely obese adolescents, was evaluated here to examine the applicability of a long-term *psychosocial* intervention for treating severe obesity.

Short-term Outcomes

Participants attending SHINE had a mean reduction of 0.19 units in BMI SDS during the first 3 months (Phase 2) – which compares favourably to other UK-based programmes [7; 23]. Upton et al. (2014) reviewed the outcomes of community-based WMPs in the UK and reported BMI SDS reductions ranging 0.01 [24] to 0.18 units [25] after 3 months of intervention [23]. Moreover, the most recent Cochrane review of international pediatric WMPs demonstrated a pooled reduction of 0.14 units in BMI SDS after 6 months of intervention [26].

THE SHINE PSI could be highly efficacious in assisting young people with weight management; 89% of the participants either reduced (88.3%) or maintained (0.6%) their BMI SDS in the first 3 months.

Establishing programme effectiveness though has long been of debate in weight management. One proposed method is to assess the volume of participants achieving a clinically significant reduction in BMI SDS (i.e. associated with cardiometabolic improvement) [27; 28]. The criteria for clinical significance is not agreed upon, but reductions of both 0.25 units and 0.50 units have been advocated and proposed as a goal for weight management [27; 28]. The findings of the current study indicate that only 35% of the cohort achieve a BMI SDS reduction ≥ 0.25 units and 5.6% achieve ≥ 0.50 unit reduction. Thus, achieving such thresholds is not likely to occur in the short-term for the

majority of WMP attendees, even at SHINE where the mean reductions in BMI SDS are greater than comparable programmes. Others too have questioned the utility of clinical significance [29]. Given the positive improvements in self-esteem, anxiety and depression at SHINE, it may be of greater benefit for policy makers and programme commissioners (those purchasing the programmes) to appraise psychosocial outcomes rather than depending on weight-related outcomes. Indeed, many young people attend WMPs to primarily improve their psychosocial health [30].

With regards to engagement in weight management, Skelton and Beech (2010) point out that 8-83% of participants will not complete a paediatric WMP [31]. The discrepancy between the two values is likely due to a multitude of factors including the target population, programme intensity, programme duration and methodological differences between studies (e.g. controlled clinical trials or service evaluations). Under service-delivery conditions and in the UK, GOALS [32] – an 18 session WMP for obese adolescents – noted a 52% programme completion rate (74/143 families), whilst WATCH IT [24] – a 3 month rolling WMP – showed a 76.6% completion rate (72/94 participants). MEND [33], the UKs largest childhood weight management provider, reported a 59.4% completion rate (8,311/13,998 participants) at 3 months. In the second phase of the SHINE intervention, participant retention was exceptionally high; 94.8% of those starting the programme completed a 3 month assessment. When examining those likely to initiate a WMP, the current study demonstrated that self-referrals were six times more likely to initiate the programme than non-self-referrals. Whilst this could indicate that self-referrals are more primed to start weight management [34], latent reasons for programme initiation will better explain this phenomena and should be considered for future research.

Long-term Outcomes

Participants opting to attend the third phase of the SHINE PSI continued to show reductions in BMI SDS. During the 12 months of intervention, SHINE participants showed a mean reduction in WC of 9.7 cm and BMI of 2.4 kg/m². In other UK-based programmes with BMI SDS data at 12 months,

GOALS [32] evidenced a 0.09 unit reduction (based on 40/143 families) and MEND [35] a 0.23 unit reduction (based on 42/54 families). Furthermore, the meta-analysis within the Cochrane review estimated a pooled reduction of 0.14 units over 12 months [26]. SHINE reported a 0.41 unit reduction within the same duration (107/347 families). When attempting to account for the 240 families who did not attend at 12 months, the LOCF analyses indicated that the change in BMI SDS was reduced, though not to the extent that values began to increase (Figure 1).

Over half of the cohort chose to attend the third phase of SHINE. In particular, those with a higher baseline BMI SDS, or with large reductions in BMI SDS, were more likely to attend the final phase. A complete unit change in BMI SDS was associated with 11 times greater odds of continuing the programme which indicates that weight loss is a strong determinant for engagement (Change in BMI SDS: Phase 2 completers = $-0.16 \text{ units} \pm 0.17$, Phase 3 attenders = -0.23 ± 0.20 , $p < 0.001$). As other studies have found that weight loss is associated with attendance [36; 37], this indicates that additional intervention or support must be targeted at those who have less noticeable changes in BMI SDS; the chronic nature of obesity needs to be recognised by families, as does the arduous journey in managing one's weight [12]. Yet for those choosing to continue into Phase 3, almost 60% (107/187 families) completed a 12 month assessment and a further decrease in average BMI SDS was observed. It is apparent that a long-term WMP is beneficial for those wishing to continue their attendance, but future exploratory work is required to clarify these associations.

Psychosocial Interventions for the Treatment of Severe Obesity

The National Institute of Health and Care Excellence (NICE) recommends that WMPs focus predominantly on dietary improvement, promotion of physical activity and behaviour modification [6]. SHINE, whilst acknowledging the NICE guidelines, goes further to recognise the psychosocial aspects of obesity. A large proportion of the SHINE PSI focuses on developing social relationships, providing techniques for stress management, overcoming bullying, and improving self-esteem (see supplement 1). As such, SHINE may be viewed to offer a more holistic approach to weight

management than traditional programmes such as MEND, Watch It and GOALS. The type of approach taken by SHINE aligns with the Health At Every Size (HAES) paradigm, whereby treatment does not only focus on the direct determinants of a disease/condition (e.g. dietary intake for obesity) [38-40]. The HAES approach would stipulate that rather than focusing treatment outcomes on weight loss, emphasis be placed on the improvement of overall health, of which weight loss may be situated within [39].

Although SHINE does not collect psychosocial measurements beyond 3 months, a key objective of the programme is to improve the psychosocial health of the young person providing assistance on weight management. Somewhat surprisingly, an improvement in the psychosocial variables was not associated with an increased likelihood of attending Phase 3, nor was it associated with a reduction in BMI SDS (data not shown). This may be explained by the low baseline scores in anxiety, depression and self-esteem relative to the scale of the measures. Notwithstanding this, obese adolescents have been shown to have a poorer quality of life (including anxiety, depression and low self-esteem) than healthy weight counterparts [3]. SHINE appraises the complex and multifaceted issues associated with obesity in its treatment strategy, and it may be that this alternative approach to weight management – which divides attention between the direct aetiology of obesity and psychosocial determinants – is a viable reason for SHINE's positive weight-related, psychosocial and retention outcomes [30; 40].

Limitations

This study was limited due to the data being collected under service-level conditions: the absence of a control group; limited data on participant attendance; and that psychosocial data were not collected beyond 3 months. That said, many WMPs are evaluated in such a manner and furthermore, many are not designed for research purposes. As researchers, we are able to utilise the data available to us to broaden knowledge in the field of adolescent obesity. Future research would therefore benefit from the addition of a control or comparison group to help make the conclusions

of this study more robust. Similarly, testing the acceptability of the programme in alternate settings (e.g. location) would help determine scalability and replication. Data collected beyond the length of the programme would too be of benefit; establishing if young people can maintain their weight status/trajectory would further demonstrate programme effectiveness. The collection of additional data (e.g. attendance data, quality of life, social-confidence etc...) would lastly improve the strength of programme findings.

Conclusion

This study has provided several key and noteworthy findings. Firstly, psychosocial interventions may be able to assist young people in the management of severe obesity, and possibly to a greater extent than other community-based WMP with published results. Not only do the results apply to anthropometric measurements, but anxiety, depression and self-esteem also improved significantly. Secondly, the participant retention within the second phase of the programme is exceptionally high, which continued to be encouraging for young people choosing to enter Phase 3. A reduction in BMI SDS and high baseline BMI SDS were shown to be strong predictors of continued engagement into Phase 3, highlighting that longer-term programmes are required by many and that such programmes should be viewed as necessary. In conclusion, current WMPs could benefit from addressing the psychosocial aspects of obesity whilst treating it as a chronic, relapsing condition and offering long-term service provision [3; 13].

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Figures

Figures 1 & 2 attached in individual, separate JPEG files. Titles and captions below. **Both are intended for reproduction in colour.**

Figure 1: Mean BMI SDS at each of the five observation points. M = Month.

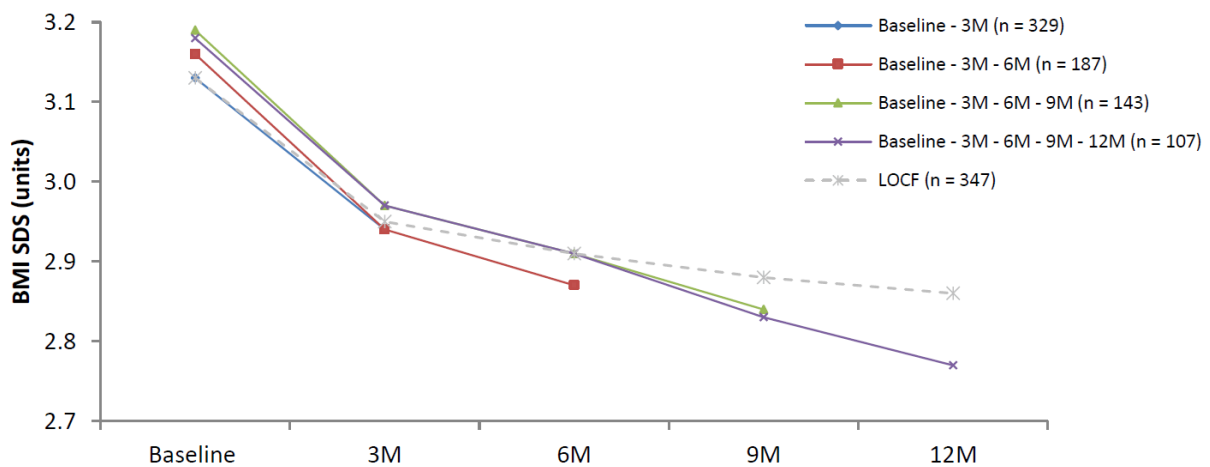
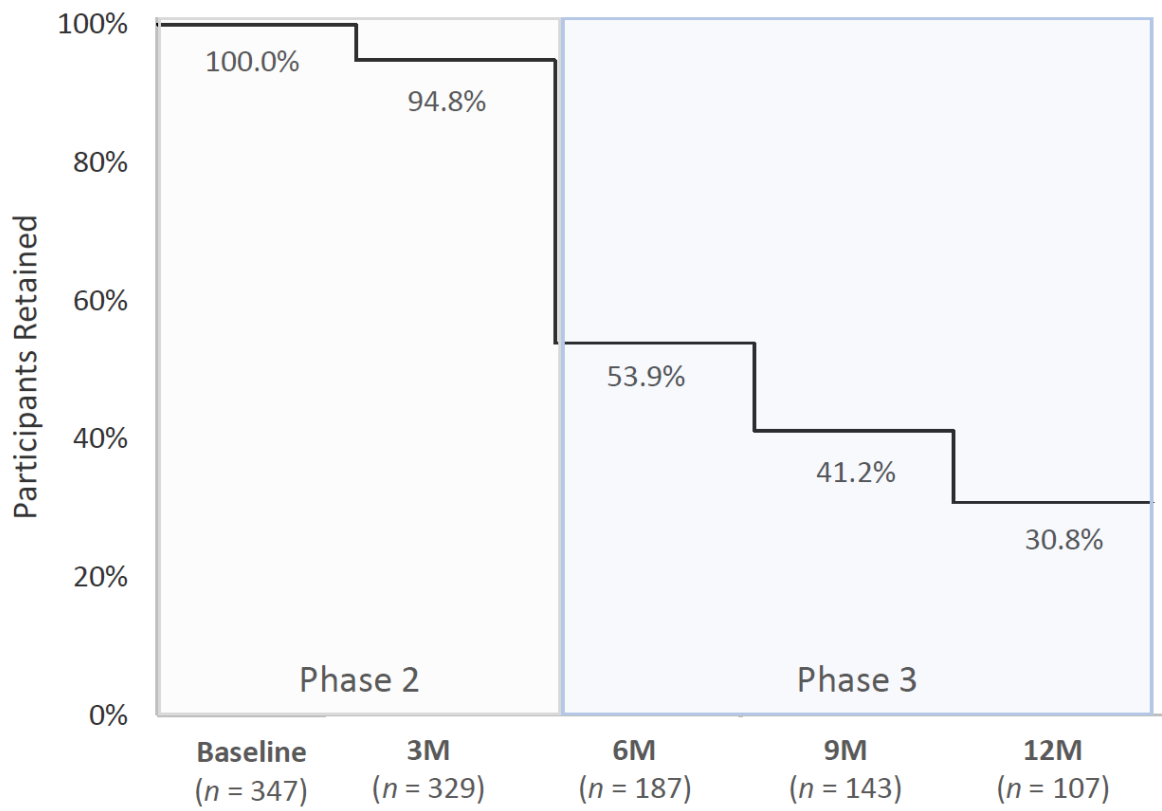


Figure 2: Participants retained at each of the five observation points, and additionally in both Phase 2 and Phase 3. Baseline group excludes Non-Initiators. M = Month.



Tables

Tables 1-3 are attached in individual, separate documents.

Table 1: Baseline Participant Entry Characteristics

Characteristic	SHINE Initiators	Including Non-Initiators
Gender (<i>n</i> , %)		
Male	177 (51%)	220 (50.6%)
Female	170 (49%)	215 (49.4%)
Age [years] (mean, SD)	12.9 (2.0)	13.1 (2.1)
Age Classification (<i>n</i> , %)		
<13.5 years	181 (52.2%)	216 (49.7%)
>13.5 years	166 (47.8%)	219 (50.3%)
Ethnicity (<i>n</i> , %)		
White	306 (88.2%)	380 (87.4%)
Non-white	41 (11.8%)	55 (12.6%)
Learning Disability (<i>n</i> , %)		
Yes	94 (27.1%)	108 (24.8%)
No	253 (72.9%)	327 (75.2%)
Referral (<i>n</i> , %)		
Self-referral	177 (51.0%)	190 (43.7%)
Non-self-referral	170 (49.0%)	245 (56.3%)
BMI [kg/m ²] (mean, SD) ^a	33.5 (7.5)	-
BMI SDS (mean, SD)	3.13 (0.54)	-
WC [cm] (mean, SD)	103.5 (14.7)	-
WC SDS (mean, SD)	3.62 (0.67)	-

^aAnthropometrics provided for initiators only as non-initiators did not have any data collected.

Table 2: Mean Change in BMI, BMI SDS, WC and WC SDS

Time Period	Measure	n	Baseline	Mean Difference (95% Confidence Interval) ^b			
				3 Months	6 Months	9 Months	12 Months
Baseline	BMI SDS	347	3.13				
	BMI (kg/m ²)	347	33.50				
	WC SDS	343	3.62				
	WC (cm)	346	103.52				
Baseline – 3M ^a	BMI SDS	329	3.13	-0.19 (-0.17, -0.21)			
	BMI (kg/m ²)	329	33.42	-1.33 (-1.18, -1.49)			
	WC SDS	325	3.61	-0.38 (-0.34, -0.42)			
	WC (cm)	328	103.41	-7.42 (-6.77, -8.08)			
Baseline - 3M - 6M	BMI SDS	187	3.16	-0.22 (-0.18, -0.26)	-0.29 (-0.24, -0.34)		
	BMI (kg/m ²)	187	33.58	-1.58 (-1.31, -1.84)	-1.87 (-1.51, -2.23)		
	WC SDS	184	3.68	-0.42 (-0.36, -0.48)	-0.49 (-0.42, -0.57)		
	WC (cm)	185	104.52	-8.34 (-7.32, -9.36)	-9.05 (-7.73, -10.36)		
Baseline - 3M - 6M - 9M	BMI SDS	143	3.19	-0.22 (-0.17, -0.27)	-0.28 (-0.22, -0.34)	-0.35 (-0.28, -0.43)	
	BMI (kg/m ²)	143	33.73	-1.58 (-1.24, -1.92)	-1.85 (-1.39, -2.31)	-2.21 (-1.68, -2.73)	
	WC SDS	139	3.69	-0.41 (-0.32, -0.49)	-0.47 (-0.36, -0.57)	-0.51 (-0.40, -0.62)	
	WC (cm)	142	104.76	-8.17 (-6.90, -9.44)	-8.62 (-6.97, -10.26)	-9.08 (-7.28, -10.87)	
Baseline - 3M - 6M - 9M - 12M	BMI SDS	107	3.18	-0.21 (-0.15, -0.27)	-0.27 (-0.19, -0.35)	-0.35 (-0.25, -0.44)	-0.41 (-0.31, -0.51)
	BMI (kg/m ²)	107	33.34	-1.41 (-1.00, -1.83)	-1.67 (-1.08, -2.26)	-2.08 (-1.39, -2.76)	-2.41 (-1.65, -3.17)
	WC SDS	103	3.69	-0.40 (-0.29, -0.51)	-0.46 (-0.32, -0.61)	-0.50 (-0.36, -0.65)	-0.57 (-0.42, -0.72)
	WC (cm)	106	104.31	-7.93 (-6.26, -9.59)	-8.23 (-6.05, -10.41)	-8.75 (-6.38, -11.11)	-9.74 (-7.31, -12.12)
Last Observation Carried Forward	BMI SDS	347	3.13	-0.18 (-0.16, -0.21)	-0.22 (-0.18, -0.26)	-0.25 (-0.21, -0.29)	-0.27 (-0.23, -0.32)
	BMI (kg/m ²)	347	33.50	-1.26 (-1.05, -1.48)	-1.42 (-1.15, -1.70)	-1.57 (-1.27, -1.87)	-1.67 (-1.35, -1.99)
	WC SDS	343	3.62	-0.36 (-0.30, -0.41)	-0.40 (-0.33, -0.46)	-0.41 (-0.35, -0.48)	-0.43 (-0.37, -0.50)
	WC (cm)	346	103.52	-7.04 (-6.11, -7.96)	-7.42 (-6.34, -8.49)	-7.60 (-6.48, -8.72)	-7.93 (-6.79, -9.06)

^aM: Month

^bSignificant difference between baseline and all time points ($p \leq 0.05$)

Table 3: Predictors of Non-Initiation (Model 1) and of Attending Phase 3 (Model 2)

Variable	Univariable Models		Multivariable Model	
	OR	95% CI	OR	95% CI
Model 1: Non-Initiators (n = 88) vs. Initiators (n = 347)				
Constant	-	-	8.34	-
Male	1.09	0.68, 1.74	-	-
Age	0.83**	0.74, 0.93	0.90	0.80, 1.01
>13.5 years	0.61*	0.34, 0.98	-	-
White ethnicity	1.41	0.73, 2.73	-	-
Self-referral	6.01***	3.21, 11.23	6.06***	3.20, 11.47
Learning disability	1.96*	1.06, 3.65	2.31*	1.21, 4.42
Model 2: Complete Phase 2 only (n = 145) vs. Attended Phase 3 (n = 185)				
Constant	-	-	0.14*	-
Male	0.79	0.51, 1.22	-	-
Age	1.01	0.91, 1.13	-	-
>13.5 years	1.03	0.67, 1.60	-	-
White ethnicity	0.96	0.49, 1.90	-	-
Self-referral	1.09	0.71, 1.69	-	-
Learning disability	0.79	0.48, 1.29	-	-
Baseline anxiety	1.04	0.98, 1.11	-	-
Change in anxiety ^a	0.98	0.91, 1.06	-	-
Baseline depression	1.01	0.95, 1.08	-	-
Change in depression ^a	1.02	0.94, 1.11	-	-
Baseline self-esteem	1.03	0.98, 1.08	-	-
Change in self-esteem ^a	0.98	0.93, 1.04	-	-
Baseline BMI SDS	1.31	0.87, 1.97	1.74*	1.11, 2.74
Change in BMI SDS ^a	6.83**	1.96, 23.88	11.17***	2.92, 42.86
Baseline WC SDS	1.43*	1.02, 2.01	-	-
Change in WC SDS ^a	2.62**	1.30, 5.30	-	-

^a Difference between baseline and 3 months

Model 1: R² = 0.12 (Cox & Snell), 0.18 (Nagelkerke). Model X² (3) = 53.47.

Model 2: R² = 0.05 (Cox & Snell), 0.06 (Nagelkerke). Model X² (2) = 15.83.

*p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001