

**Original citation:**

Johnson, Rebecca E., Robertson, Wendy, Towey, Marsha, Stewart-Brown, Sarah L. and Clarke, Aileen. (2017) Changes over time in mental well-being, fruit and vegetable consumption and physical activity in a community-based lifestyle intervention : a before and after study. Public Health, 146 . pp. 118-125.

**Permanent WRAP URL:**

<http://wrap.warwick.ac.uk/87544>

**Copyright and reuse:**

The Warwick Research Archive Portal (WRAP) makes this work of researchers of the University of Warwick available open access under the following conditions.

This article is made available under the Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND 4.0) license and may be reused according to the conditions of the license. For more details see: <http://creativecommons.org/licenses/by-nc-nd/4.0/>

**A note on versions:**

The version presented in WRAP is the published version, or, version of record, and may be cited as it appears here.

For more information, please contact the WRAP Team at: [wrap@warwick.ac.uk](mailto:wrap@warwick.ac.uk)

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

## Public Health

journal homepage: [www.elsevier.com/puhe](http://www.elsevier.com/puhe)

## Original Research

# Changes over time in mental well-being, fruit and vegetable consumption and physical activity in a community-based lifestyle intervention: a before and after study



R. Johnson <sup>a,\*</sup>, W. Robertson <sup>a</sup>, M. Towey <sup>b</sup>, S. Stewart-Brown <sup>a</sup>, A. Clarke <sup>a</sup>

<sup>a</sup> Division of Health Sciences, Warwick Medical School, Gibbet Hill Road, Coventry, CV4 7AL, UK

<sup>b</sup> Coventry City Council, Coventry, CV1 1GF, UK

## ARTICLE INFO

## Article history:

Received 14 June 2016

Received in revised form

2 December 2016

Accepted 6 January 2017

## Keywords:

Fruit and vegetable consumption

Physical activity

Mental well-being

Mental health

Lifestyle intervention

## ABSTRACT

**Objectives:** There is a theoretical basis for believing that healthy lifestyle interventions can improve mental well-being and evidence to show that mental well-being is protective of future health. This study contributes to the evidence base by examining changes in mental well-being associated with the One Body One Life (OBOL) healthy lifestyle programme in a community setting in the West Midlands.

**Study design:** Quantitative, before and after the evaluation.

**Methods:** We conducted a before and after study of the lifestyle intervention 'OBOL', a multi component intervention that includes exercise and healthy eating education. Mental well-being was measured with the Warwick–Edinburgh Mental Well-being Scale. Physical activity and fruit and vegetable consumption were self-reported. Measures were collected before and after the 12-week intervention and three months post completion. Non-parametric tests were used to assess differences between groups, and linear mixed models were used to assess change over time.

**Results:** Four hundred and eighty-one (81% of attendees) adult participants completed a valid Warwick–Edinburgh Mental Well-being Scale before starting OBOL; of whom, 63.8% completed the Warwick–Edinburgh Mental Well-being Scale immediately post intervention and 25.2% at three months. Mental well-being levels increased significantly ( $P < 0.001$ ) over the course of the intervention and were sustained at the three-month follow-up (baseline median Warwick–Edinburgh Mental Well-being Scale score = 48 [interquartile range 41–55], completion = 53 [interquartile range 46–57], 3-month follow-up = 52 [interquartile range 46–56]). Change in mental well-being was clinically significant after accounting for age and gender. Changes in both fruit and vegetable consumption and physical activity appeared to explain some but not all of the variation in mental well-being.

**Conclusion:** We found significant improvements in mental well-being among participants directly after the intervention which were sustained at the three-month follow-up. These

Abbreviations: OBOL, One Body One Life; WEMWBS, Warwick–Edinburgh Mental Well-being Scale.

\* Corresponding author. Tel.: +44 02476 575 207.

E-mail addresses: [rebecca.johnson@warwick.ac.uk](mailto:rebecca.johnson@warwick.ac.uk) (R. Johnson), [w.robertson@warwick.ac.uk](mailto:w.robertson@warwick.ac.uk) (W. Robertson), [Sarah.stewart-brown@warwick.ac.uk](mailto:Sarah.stewart-brown@warwick.ac.uk) (S. Stewart-Brown), [aileen.clarke@warwick.ac.uk](mailto:aileen.clarke@warwick.ac.uk) (A. Clarke).

<http://dx.doi.org/10.1016/j.puhe.2017.01.012>

0033-3506/© 2017 The Authors. Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

findings contribute to a growing body of knowledge on the contribution of lifestyle interventions to promoting and sustaining mental well-being.

© 2017 The Authors. Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## Introduction

The Foresight Report on Mental Capital and Well-being<sup>1</sup> made a powerful case, on economic and health grounds, for the promotion of positive mental health and well-being partly on the grounds that it is protective of future health.<sup>2,3</sup> This report, coupled with the development of valid and reliable measures of mental well-being,<sup>4,5</sup> has fuelled the development of UK policy relating to mental well-being<sup>6</sup> and research to identify effective interventions.

Mental well-being and positive mental health are regarded as synonymous, but the former term has gained more traction in public health practice in the UK because general and clinical populations relate to it more readily than to the term positive mental health. Both terms describe a state of positive affect and psychological functioning. Positive affect includes emotions like happiness, calm, contentment or satisfaction with life; positive functioning includes capabilities like autonomy, motivation, engagement and positive relationships. Self-acceptance and self-confidence are important components of mental well-being which include features of both affect and functioning.<sup>7,8</sup> The term mental health has been used in many ways; we use it here to refer to the spectrum of mental health from problems and disorders to well-being.

There are strong theoretical reasons to believe that healthy lifestyle programmes, which aim to increase physical activity and improve diet, could improve mental well-being. This perspective is reflected in UK public health outcomes framework.<sup>6,9</sup> Physical activity has been shown to improve mental health in general and clinical populations,<sup>10–18</sup> although the majority of the latter studies use measures of mental illness, which may lack sensitivity to detect change in mental well-being<sup>10,17,18</sup> and limit usefulness for universal, community-based interventions. Several studies have shown a close epidemiological association between fruit and vegetable consumption and mental health (both illness and well-being)<sup>19,20</sup> and a small number have provided some evidence suggesting causality.<sup>21,22</sup> In addition, group-based activities and skilled facilitator support could improve mental well-being via reduction in social isolation, increase in peer support, increase in self-acceptance through sharing of problems and acceptance by group, and increase in self-esteem from managing to change.<sup>23–25</sup> Preliminary research on healthy lifestyle interventions has suggested improvements in mental well-being as measured by the Warwick–Edinburgh Mental Well-being Scale (WEMWBS).<sup>26</sup>

The evaluation of health promoting interventions offered on an open access basis in community settings can be more complex than evaluation of treatments for illness in clinical settings. Recruitment to programmes can be difficult and

difficulty can be enhanced by the study setting. It is more difficult to achieve complete control over the environment and usually impossible to achieve ‘blinding’ for participants. In addition, interventions which require personal engagement for success may be influenced negatively by the controlled setting of trials.<sup>27</sup> Observational studies of interventions in natural settings therefore play a role in the development of public health policy.<sup>28</sup>

This study aimed to investigate the extent of change in mental well-being associated with the One Body One Life (OBOL) healthy lifestyle programme and to assess the extent to which any change was mediated by lifestyle change. OBOL was offered in Coventry, England, on an open access basis following general publicity, providing the opportunity for a pragmatic observational study. The main components of OBOL are increasing fruit and vegetable consumption and physical activity; recent evaluation has shown significant increases in physical activity and fruit and vegetable consumption, and small but significant decreases in body mass index (BMI)/BMI percentile among adults and children.<sup>29</sup>

## Method

### Description of the intervention

OBOL is a 12-week family-based intervention designed to create lifestyle behaviour change through education and activity sessions for any age group.<sup>29</sup> The programme was developed by the ‘Be Active Be Healthy’ team within Coventry City Council, using NICE Clinical Guideline 43<sup>30</sup> in response to the ‘Choosing Health: Making healthy choices easier’ White Paper.<sup>31</sup> It is underpinned by the standard tools derived from behaviour change theory for weight management including goal-setting, self-monitoring and relapse prevention.<sup>32</sup> The programme maintains a strong emphasis on being ‘fun and interactive’.

Courses were delivered in a community setting by qualified coaches using a behavioural approach to change. Coaches were qualified to Register of Exercise Professionals level 3 on the Exercise Referral Qualification. Each course includes 12 × 90-min weekly sessions divided into a 45-min exercise focussing on gently improving fitness using basketball, netball, football (soccer), rounders, dance and Tai Chi, and a 45-min workshop on healthy eating including healthy eating tips and demonstrations, health checks and motivational coaching to improve expectations and identify readiness for change.<sup>29</sup>

Participants were recruited from the local population using media publicity (local radio and newsprint), GP ‘referral’ and posters in community centres and gathering places. All those presenting were included provided they had no pre-existing

heart conditions and had signed a waiver and consent form stating so.

### Recruitment

All adults (aged 16+ years) who attended an OBOL course from April 2011 to April 2012 were invited to take part in the evaluation by members of the OBOL team who offered them information about the study and its purpose and gained written consent.

### Sample size

A sample size estimation based on published change data using WEMWBS was undertaken.<sup>26,33</sup> We used G\*Power to estimate sample size with  $\alpha = 0.05$ , 90% power and a moderate effect size (0.5) for paired t tests.<sup>34</sup> This resulted in an estimated 44 participants needed to demonstrate change. The number agreeing to take part in the evaluation exceeded this estimate by a factor of 10, and we maximised the use of this sample because the study on which it was based<sup>26</sup> included a range of community-based studies that saw a wide range of sample and effect sizes. We used this as a guide, because there were no directly applicable interventions from which we could draw the most accurate sample size estimate. Based on previous waves of OBOL,<sup>29</sup> high dropout rates and low follow-up was anticipated. Finally, the larger sample allowed for subgroup analysis with less likelihood of committing a Type II error. We defined clinically important/meaningful change to be 3 or more WEMWBS points.<sup>26</sup>

### Evaluation design

The evaluation was developed using the Standard Evaluation Framework for Weight Management Interventions recommended by the National Obesity Observatory.<sup>35</sup> Data were collected at three time points by the OBOL team: before the first session (baseline/T1), after the last session at 12 weeks (completion/T2) and three months after the completion of the last session (follow-up/T3). Baseline and completion data were collected using a questionnaire at the first and last weeks of the intervention. Participants were invited back to complete a follow-up questionnaire at three months. Participants who did not attend in person were followed up by OBOL staff via phone and post.

### Measures

Mental well-being was measured using WEMWBS.<sup>5</sup> WEMWBS is a positively worded 14-item scale covering affective and psychological functioning constructs of mental well-being which has been found to be valid and reliable in diverse populations of people aged 13 to 75+ years.<sup>5,36–38</sup> Scores are derived from summing responses to a 5-point Likert-type scale and range from 14 to 70 with high scores representing greater mental well-being. Population reference data from the Health Survey for England report median WEMWBS scores of 53 for adult (16+ years old) men and women.<sup>39</sup>

WEMWBS was incorporated into an existing OBOL evaluation questionnaire addressing behaviours and attitudes to

physical activity, healthy eating, general well-being and standard demographic questions.

Physical activity and walking were self-reported (number of episodes of physical activity or walking of at least 30 min per week). Fruit and vegetable consumption was self-reported using the question: 'on a typical day, how much fruit and vegetables do you eat (this can be dried, fresh, frozen or tinned; one portion is the same as a handful)'. This question is similar to the Health Survey for England question on fruit and vegetable consumption, except that OBOL asked about portions on a 'typical day' and Health Survey for England requests the number of portions eaten in the last 24 h.<sup>40</sup> Predefined categories were used in both questions, and ranged from 0 to 5+ (either portions of fruits and vegetables consumed or episodes of physical activity).

### Statistical analyses

Analyses were carried out using IBM SPSS, version 22.<sup>41</sup> Descriptive analysis was undertaken using means and standard deviations. Distribution of the difference between time points was examined for normality using histograms, normal Q–Q plots, observed values outliers and the Kolmogorov–Smirnov test. Chi-squared with Yate's correction was used to determine whether differences between socio-demographic groups were significant. Unpaired t tests were used to determine the statistical significance of differences between socio-demographic and baseline scores for completing vs non-completing individuals and between baseline-only participants and those completing the 3-month post intervention follow-up, to examine if those lost to follow-up were systematically different from those included in the analysis. Inferential analysis was undertaken to identify change in WEMWBS over time, together with statistical significance, and effect size of the change.<sup>33</sup> Effect sizes were calculated using  $r = Z/\sqrt{N}$ .<sup>42,43</sup> Wilcoxon's signed-rank test were used to assess significance. Median WEMWBS scores and interquartile ranges are reported.

To assess change over time we fitted a linear mixed model, with time as a categorical variable, and compared baseline WEMWBS scores to 10–12 weeks scores (completion) and to six month scores (the 3-month follow-up). Individual profiles indicated similar increases for participants from baseline to 10–12 weeks (approximately parallel profiles) and convergence to the same score for all participants at six months so we fitted a random intercept term and a random slope term for the difference between baseline and six months/follow-up scores only. The fitted models also adjusted for gender, age, fruit and vegetable consumption, physical activity and walking.

---

## Results

### Participant characteristics

Of the 586 participants enrolled in OBOL, 481 had valid WEMWBS scores at baseline (82%), 307 at completion (64% of baseline) and 121 at follow-up three months after the completion (39% of completing participants; 25.2% of those

with scores at baseline). Eighty-one percent were women and 26% were aged 35 to 44 years, but all ages were represented from 16 to 75+ years (Table 1). Differences in WEMWBS scores between time points were not normally distributed, therefore Wilcoxon's signed-rank test was used to assess change between time points. We identified that those answering 'other' as their ethnicity, or not giving an ethnicity, were more likely not to complete OBOL completion and follow-up questionnaires. There were no other statistically significant socio-demographic differences identified. We did not identify statistically significant differences between mean baseline WEMWBS score among those who completed the evaluation (T2) compared to those who did not (completers WEMWBS = 47.55 [SD 8.66] vs non-completers WEMWBS = 46.63 [SD 9.57],  $P = 0.38$ ) nor between non-completers and those completing the 3-month post completion follow-up (T3; WEMWBS = 47.00 [SD 9.34],  $P = 0.78$ ). The data that we have do not overall suggest differential loss to follow-up on the basis of demographic grouping of age, gender or ethnicity, or baseline WEMWBS scores.

#### Change in mental well-being, physical activity and fruit and vegetable consumption over time

Median values of mental well-being and healthy lifestyle variables at each time point for baseline (T1), completion (T2) and the 3-month follow-up (T3) are reported in Table 2, using data from all participants who completed WEMWBS between T1 to T2, T2 to T3, and T1 to T3.

#### Changes in mental well-being in OBOL participants

Mental well-being levels increased significantly from baseline (median: 48, interquartile range (IQR) 41–55) to completion (median: 53, IQR 46–57,  $P < 0.001$ ; Table 2) with a moderate effect size (0.51). Improvements in mental well-

being were sustained from completion to the 3-month follow-up with no significant differences between scores ( $P = 0.45$ ). Among those with data from baseline to the 3-month follow-up, there was a similar effect size change in levels of participant mental well-being (47–52,  $P < 0.001$ ) as observed from baseline to completion.

#### Healthy lifestyle variables

Significant increases in moderate physical activity ( $P < 0.001$ ) and in portions of fruits and vegetables consumed ( $P < 0.001$ ) were observed between baseline and completion (Table 2). Fruit and vegetable consumption showed no significant change ( $P = 0.334$ ) among participants from completion to follow-up, but there was a significant decrease in frequency of moderate physical activity ( $P = 0.003$ ) at this time.

#### Linear mixed models of the OBOL intervention on WEMWBS scores

In the mixed effects models (Table 3), increases in mental well-being remained significant at both time points after adjusting for age and gender (model one): baseline to completion ( $\beta = 4.27$ , 95% confidence interval (CI): 3.39, 5.15,  $P < 0.001$ ) and baseline to follow-up (3-months post intervention;  $\beta = 3.82$ , 95% CI: 2.55, 5.10,  $P < 0.001$ ). Model two (adjusting in addition for change in fruit and vegetable consumption) and model three (adjusting for physical activity in addition to gender and age) show change in these lifestyle variables to be accounting for some but not all of the change in mental well-being. The extent of change accounted for is greater for fruit and vegetable consumption than for physical activity. Model four, in which all lifestyle variables including walking are included, show that the extent of change in WEMWBS accounted for by change in fruit and vegetable consumption is largely independent of

**Table 1 – One Body One Life (OBOL) participant characteristics.**

| Participant characteristics | N total   | n valid @ baseline T1 | n valid @ completion T2 | n valid @ 3 m follow-up T3 | Did not complete WEMWBS |
|-----------------------------|-----------|-----------------------|-------------------------|----------------------------|-------------------------|
| Total                       | 586       | 481                   | 307                     | 121                        | 277                     |
| <b>Gender</b>               |           |                       |                         |                            |                         |
| Men                         | 113 (19%) | 85 (18%)              | 58 (19%)                | 18 (15%)                   | 55 (20%)                |
| Women                       | 473 (81%) | 396 (82%)             | 249 (81%)               | 103 (85%)                  | 224 (80%)               |
| <b>Age in years</b>         | 584       |                       |                         |                            |                         |
| 16–24                       | 65 (11%)  | 54 (11%)              | 26 (9%)                 | 10 (8%)                    | 39 (14%)                |
| 25–34                       | 108 (18%) | 92 (19%)              | 56 (18%)                | 22 (18%)                   | 52 (19%)                |
| 35–44                       | 151 (26%) | 129 (27%)             | 84 (27%)                | 39 (32%)                   | 67 (24%)                |
| 45–54                       | 92 (16%)  | 75 (16%)              | 45 (15%)                | 14 (12%)                   | 47 (17%)                |
| 55–64                       | 63 (11%)  | 51 (11%)              | 38 (12%)                | 17 (14%)                   | 25 (9%)                 |
| 65–74                       | 55 (9%)   | 42 (9%)               | 32 (10%)                | 10 (8%)                    | 23 (8%)                 |
| 75+                         | 50 (9%)   | 38 (8%)               | 26 (9%)                 | 9 (7%)                     | 24 (9%)                 |
| <b>Ethnicity</b>            | 586       |                       |                         |                            |                         |
| White                       | 377 (64%) | 324 (71%)             | 208 (71%)               | 83 (72%)                   | 169 (61%)               |
| Asian                       | 103 (18%) | 82 (18%)              | 54 (18%)                | 24 (21%)                   | 49 (18%)                |
| Black                       | 37 (6%)   | 27 (6%)               | 19 (7%)                 | 4 (4%)                     | 18 (6%)                 |
| Mixed                       | 19 (3%)   | 17 (4%)               | 10 (4%)                 | 3 (3%)                     | 9 (3%)                  |
| Other/not given             | 50 (9%)   | 7 (2%)                | 3 (1%)                  | 2 (2%)                     | 34 (12%)                |

WEMWBS: Warwick-Edinburgh Mental Well-being Scale.

**Table 2 – Changes in WEMWBS, physical activity and fruit and vegetable consumption at baseline (T1), completion of OBOL (T2) and 3-month follow-up (T3).**

| Variable (median value)                        | Time point              | N (people) | T1 (IQR)    | T2 (IQR)   | T3 (IQR)     | Z score            | Sig. P-value | Effect size |
|--|-------------------------|------------|-------------|------------|--------------|--------------------|--------------|-------------|
| WEMWBS   | Baseline to completion  | 274        | 48 (41–55)  | 53 (46–57) | –            | –8.54 <sup>a</sup> | P < 0.001    | 0.51        |
|  | Completion to follow-up | 99         | –           | 51 (46–57) | 52 (46–56)   | –0.75 <sup>b</sup> | P = 0.45     | 0.08        |
|  | Baseline to follow-up   | 112        | 47 (41–55)  | –          | 52 (46–56)   | –4.18 <sup>a</sup> | P < 0.001    | 0.40        |
| Physical activity >30 min in past week (times) | Baseline to completion  | 184        | 4.0 (3–6)   | 5.0 (3–7)  | –            | –4.62 <sup>a</sup> | P < 0.001    | 0.34        |
|  | Completion to follow-up | 76         | –           | 5.0 (3–7)  | 4.0 (2–5.25) | –2.99 <sup>a</sup> | P = 0.003    | 0.34        |
|  | Baseline to follow-up   | 63         | 4.0 (3–6.5) | –          | 4.0 (2–5)    | –0.14 <sup>a</sup> | P = 0.888    | 0.02        |
| Walking >30 min in past week (times)           | Baseline to completion  | 192        | 4.5 (3–7)   | 5.0 (3–7)  | –            | –2.44 <sup>a</sup> | P = 0.015    | 0.18        |
|  | Completion to follow-up | 79         | –           | 5.0 (3–7)  | 5.0 (3–7)    | –0.28 <sup>a</sup> | P = 0.779    | 0.03        |
|  | Baseline to follow-up   | 76         | 4.5 (3–6)   | –          | 5.0 (3–7)    | –1.53 <sup>a</sup> | P = 0.125    | 0.18        |
| Fruits and vegetables, (portions per day)      | Baseline to completion  | 261        | 3.0 (2–4)   | 4.0 (3–5)  | –            | –8.06 <sup>a</sup> | P < 0.001    | 0.50        |
|  | Completion to follow-up | 96         | –           | 4.0 (3–5)  | 4.0 (3–5)    | –0.97 <sup>a</sup> | P = 0.334    | 0.10        |
|  | Baseline to follow-up   | 106        | 3.0 (2–4)   | –          | 4.0 (3–5)    | –4.36 <sup>a</sup> | P < 0.001    | 0.42        |

IQR, interquartile range; OBOL, One Body One Life; WEMWBS, Warwick-Edinburgh Mental Well-being Scale.

<sup>a</sup> Based on negative ranks.

<sup>b</sup> Based on positive ranks; all tests conducted using Wilcoxon signed-rank test.

change in the physical activity. Change in WEMWBS following adjustment is reduced but remains significant for baseline to completion, and baseline to follow-up.

**Table 3 – Mixed effects model of lifestyle variables and mental well-being over time.<sup>a,c</sup>**

| Time                            | Estimate (b) | SE (b) | 95% CI      | P value <sup>b</sup> |
|---------------------------------|--------------|--------|-------------|----------------------|
| <b>Model 1</b>                  |              |        |             |                      |
| Baseline to completion          | 4.27         | 0.45   | 3.39, 5.15  | 0.000                |
| Baseline to follow-up           | 3.82         | 0.65   | 2.55, 5.10  | 0.000                |
| Age                             | –0.77        | 0.78   | –2.30, 0.77 | 0.680                |
| Gender                          | –0.81        | 0.99   | –2.77, 1.14 | 0.382                |
| <b>Model 2</b>                  |              |        |             |                      |
| Baseline to completion          | 3.26         | 0.47   | 2.33, 4.19  | 0.000                |
| Baseline to follow-up           | 2.97         | 0.66   | 1.67, 4.26  | 0.000                |
| Age                             | –0.13        | 0.22   | –0.58, 0.31 | 0.562                |
| Gender                          | –1.79        | 1.00   | –3.78, 0.19 | 0.076                |
| Fruit and vegetable consumption | 1.52         | 0.26   | 1.01, 2.03  | 0.000                |
| <b>Model 3</b>                  |              |        |             |                      |
| Baseline to completion          | 3.34         | 0.50   | 2.36, 4.33  | 0.000                |
| Baseline to follow-up           | 2.90         | 0.73   | 1.47, 4.33  | 0.000                |
| Age                             | 0.35         | 0.23   | –0.11, 0.80 | 0.131                |
| Gender                          | –0.92        | 1.05   | –2.98, 1.14 | 0.381                |
| Physical activity               | 0.55         | 0.15   | 0.24, 0.87  | 0.000                |
| <b>Model 4</b>                  |              |        |             |                      |
| Baseline to completion          | 2.58         | 0.54   | 1.52, 3.63  | 0.000                |
| Baseline to follow-up           | 2.30         | 0.76   | 0.81, 3.80  | 0.003                |
| Age                             | 0.17         | 0.24   | –0.31, 0.64 | 0.485                |
| Gender                          | –1.79        | 1.08   | –3.92, 0.32 | 0.097                |
| Fruit and vegetable consumption | 1.26         | 0.30   | 0.66, 1.85  | 0.000                |
| Physical activity               | 0.40         | 0.19   | 0.03, 0.77  | 0.032                |
| Walking                         | –0.07        | 0.18   | –0.41, 0.28 | 0.704                |

<sup>a</sup> Estimate b = beta coefficient, model intercept; b expressed in Warwick-Edinburgh Mental Well-being Scale (WEMWBS) units. WEMWBS units range from 14–70 where 70 is best possible mental wellbeing.

<sup>b</sup> Final analytical sample: baseline n = 481, completion n = 307, follow-up n = 121.

<sup>c</sup> After adjusting for multiple comparisons, the familywise error rate = 0.008.

## Discussion

We undertook a before and after evaluation to assess change in mental well-being associated with a community-based healthy living intervention focussing on fruit and vegetable consumption and physical activity (OBOL). We found significant improvements in mental well-being among participants directly after the intervention which was sustained at the 3-month follow-up. Physical activity and fruit and vegetable consumption (but not walking) also increased over the course of the intervention but only increases in fruit and vegetable consumption were sustained at follow-up. Fruit and vegetable consumption showed a greater increase over time than physical activity. Our linear mixed models confirmed these findings. Moderate effect size changes in WEMWBS were observed over time after accounting for age and gender with change scores falling above the 3 points cut point shown to be clinically meaningful.<sup>26</sup> Change in fruit and vegetable consumption and change in physical activity independently explained some, but not all of the change in mental well-being associated with the intervention; the extent of variability explained by fruit and vegetable consumption was greater than that for physical activity. This suggests an association between improvements in mental well-being and increases in fruit and vegetable consumption. In the wider literature, there is conflicting evidence about the causal pathway between fruit and vegetable consumption, physical activity and mental health (for which there is more evidence) and mental well-being (for which there is less evidence). For physical activity, most reviews find beneficial effects of exercise on mental health; the evidence on exercise for depression is less conclusive.<sup>18,44,45</sup>

The combinations of mechanisms which might operate and the different contexts which might be important to produce the associations between physical activity and mental well-being are not well understood.<sup>46</sup> It could be that the type, amount or intensity of physical activity education in OBOL is not enough to deliver a sustained increase, reducing any possible effects on mental well-being. Nevertheless small changes were observed but not sustained.

Our study strengthens the evidence base suggesting that fruit and vegetable consumption (and the associated nutritional components) is associated with improvements in mental well-being<sup>19,20</sup> and more widely, enhances quality of mental and physical functioning.<sup>22</sup> While we were unable to investigate the basis for the direct association of OBOL with improvements in mental well-being, literature exists that supports the biological and nutritional plausibility of fruit and vegetable consumption improving health.<sup>47–49</sup> Evidence also exists that suggests improvements in physical and mental well-being in association with diets rich in fruits and vegetables,<sup>50</sup> improvements in mood following consumption of vitamin c-rich fruits,<sup>51</sup> associations between fruit and vegetable consumption and greater eudaemonic well-being,<sup>52</sup> improvements in mental and physical health when snacking on fruit vs chocolate or crisps<sup>53</sup> and for general weight management.<sup>54</sup>

This study supports theory suggesting that healthy lifestyle interventions could improve mental well-being. It suggests that the improvement in the latter is only partly explained by improvements in physical activity and healthy eating. The independent effect on mental well-being could prove generic to group based, open access, community-based interventions.

### **Implications for research**

Replication of this finding is required in other studies that could aim to include a control condition, achieve higher rates of follow-up and use objective measures of fruit and vegetable consumption and physical activity and that measure BMI or waist circumference. Although our results are consistent with a causal effect, they cannot prove this and further studies are essential. The relationship between change in mental well-being and change in fruit and vegetable consumption should be tested in different samples and contexts to determine the generalisability and directionality of this finding. Qualitative research to understand the theory and mechanisms surrounding why healthy living interventions might improve mental well-being independently of lifestyle changes is required.

### **Implications for practice**

Further examination of the way group based, open access lifestyle interventions can affect mental well-being is important for public health practice, the ultimate aim of which is the improvement of general well-being. The possible effect on mental well-being of other group base intervention merits consideration.

### **Limitations of this study**

Only 80% of the participants in the OBOL course took part in the evaluation. Loss to follow-up was substantial at completion with a third of participants failing to complete this stage and more still at 3-month follow-up (three quarters of those assessed by the baseline). This is a problem experienced by many 'real world' community programmes, particularly surrounding participant drop-out,<sup>55</sup> and our figures compare well with those in many community-based evaluations. Though

we did not detect many differences in demographic or mental well-being levels between those completing OBOL evaluations and those who did not, this does not rule out differences between these groups that were not quantitated. We considered data imputation but because we had sufficient data and our investigation suggested no differential loss to follow-up this was not considered to add value to the study.<sup>56,57</sup>

Self-report is not entirely reliable, and it is possible that participants may have over or under estimated the amount of fruits and vegetables they consume,<sup>58</sup> the amount of physical activity they take, or the amount of change in either, with responses potentially influenced by social desirability bias.<sup>59</sup> Other studies could account for this by using objective measures of physical activity (e.g. accelerometer) and fruit and vegetable consumption,<sup>35,60</sup> but these would substantially increase the cost of evaluation. It is possible that reported changes could be due to factors that we did not study such as changes in other dietary habits.

BMI was measured in OBOL, but unfortunately we did not have the access to these data. Change in BMI may have been an important factor in the network of associations at play in OBOL. OBOL may partly have an effect on well-being via change in BMI, and OBOL did in fact demonstrate moderate changes in BMI in previous OBOL cohorts.<sup>29</sup> Future studies should definitely include objective measures of BMI and of change in BMI to further explore this relationship.

Due to the study design, we cannot determine the causal pathway of the relationship between mental well-being and fruit and vegetable consumption (in addition to physical activity) with any degree of certainty; further testing and replication of the finding in different contexts is required.

Conducting the study on an intervention embedded in practice meant tight budgets, relatively high turnover rates of staff working to capacity and technical and logistical challenges to overcome in situ. Even though our study was pragmatic, we identified substantial clinically and statistically significant changes in mental well-being of importance both for future research and public health practice.

### **Conclusions**

We found statistically significant and clinically meaningful improvements in mental well-being among participants directly after the OBOL intervention which was sustained at the 3-month follow-up. Our findings suggest that public health interventions aiming at improving physical health also improve mental well-being, and this relationship is partly but not wholly explained by fruit and vegetable consumption and physical activity. These findings contribute to a growing body of knowledge on the contribution of lifestyle interventions to promoting and sustaining mental well-being.

---

### **Author statements**

### **Acknowledgements**

The authors thank Dr Peter Kimani and Dr Chris Stinton for their statistical advice. They also wish to thank the staff and participants of OBOL for their time and commitment.

### Ethical approval

Ethical approval was obtained from the University of Warwick Biomedical Research Ethics Committee 16 June 2011 (ref:128/07/2011).

### Funding

The work of RJ, WR and AC are supported by the National Institute for Health Research (NIHR) Collaborations for Leadership in Applied Health Research and Care West Midlands (CLAHRC-WM) initiative (wmclahrc-2014-1).

### Competing interests

SSB is one of the original developers of the Warwick–Edinburgh Mental Well-being Scale and the remaining authors declare no competing interest.

### Author contributions

RJ conceptualised the study and the paper, conducted the data analysis and interpretation and wrote and edited significant portions of the paper.

WR advised on the analysis of the paper and contributed to the writing and editing of the paper.

MT conducted the OBOL evaluations and collected OBOL data and contributed to the writing of the paper.

SSB advised on data analysis and interpretation and contributed to the writing and editing of the paper.

AC advised on data analysis and contributed to the writing and editing of the paper.

### REFERENCES

- Beddington J, Cooper CL, Field J, Goswami U, Huppert FA, Jenkins R, et al. The mental wealth of nations. *Nature* 2008;455:1057–60.
- Chida Y, Steptoe A. Positive psychological well-being and mortality: a quantitative review of prospective observational studies. *Psychosom Med* 2008;70(7):741–56. <http://dx.doi.org/10.1097/PSY.0b013e31818105ba>. Epub 2008 Aug 25.
- Cohen S, Pressman SD. Positive affect and health. *Curr Dir Psychol Sci* 2006;15(3):122–5.
- Bech P. *Quality of life in the psychiatric patient*. London: Mosby-Wolfe; 1998.
- Tennant R, Hiller L, Fishwick R, Platt S, Joseph S, Weich S, et al. The Warwick–Edinburgh mental well-being scale (WEMWBS): development and UK validation. *Health Qual Life Outcomes* 2007;5:63.
- Public Health England. *Improving outcomes and supporting transparency*. 2013. <https://www.gov.uk/government/publications/healthy-lives-healthy-people-improving-outcomes-and-supporting-transparency> (accessed 1 December 2013).
- Ryff CD. Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *J Pers Soc Psychol* 1989;57:1069–81.
- Huppert, Felicia A, Baylis N. Well-being: towards an integration of psychology, neurobiology and social science. *Philos Trans R Soc Lond B Biol Sci* 2004;359:1447–51.
- Public Health England. *Improving outcomes and supporting transparency*. 2011. <https://www.gov.uk/government/publications/healthy-lives-healthy-people-improving-outcomes-and-supporting-transparency> (accessed 12 November 2011).
- Fox KR. The influence of physical activity on mental well-being. *Public Health Nutr* 1999;2:411–8.
- Moses J, Steptoe A, Mathews A, Edwards S. The effects of exercise training on mental well-being in the normal population: a controlled trial. *J Psychosom Res* 1989;33:47–61.
- Scully D, Kremer J, Meade MM, Graham R, Dudgeon K. Physical exercise and psychological well-being: a critical review. *Br J Sports Med* 1998;32:111–20.
- Saxena S, Van Ommeren M, Tang KC, Armstrong TP. Mental health benefits of physical activity. *J Ment Health* 2005;14:445–51.
- Hassmén P, Koivula N, Uutela A. Physical exercise and psychological well-being: a population study in Finland. *Prev Med* 2000;30:17–25.
- Windle G, Hughes D, Linck P, Russell I, Woods B. Is exercise effective in promoting mental well-being in older age? A systematic review. *Aging Ment Health* 2010;14:652–69.
- Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. *Br J Sports Med* 2011;45:886–95.
- Conn VS. Depressive symptom outcomes of physical activity interventions: meta-analysis findings. *Ann Behav Med* 2010;39:128–38.
- Cooney GM, Dwan K, Greig CA, Lawlor DA, Rimer J, Waugh FR, et al. Exercise for depression. *Cochrane Database Syst Rev* 2013;9.
- Blanchflower DG, Oswald AJ, Stewart-Brown S. Is psychological well-being linked to the consumption of fruit and vegetables? *Soc Indic Res* 2012. <http://dx.doi.org/10.1007/s11205-012-0173-y>.
- Stranges S, Samaraweera PC, Taggart F, Kandala NB, Stewart-Brown S. Major health-related behaviours and mental well-being in the general population: the Health Survey for England. *BMJ Open* 2014;4(9):1–9. e005878.
- White BA, Horwath CC, Conner TS. Many apples a day keep the blues away—daily experiences of negative and positive affect and food consumption in young adults. *Br J Health Psychol* 2013;18:782–98.
- Steptoe A, Perkins-Porras L, Hilton S, Rink E, Cappuccio FP. Quality of life and self-rated health in relation to changes in fruit and vegetable intake and in plasma vitamins C and E in a randomised trial of behavioural and nutritional education counselling. *Br J Nutr* 2004;92:177–84.
- Michie S, Johnston M, Francis J, Hardeman W, Eccles M. From theory to intervention: mapping theoretically derived behavioural determinants to behaviour change techniques. *Appl Psychol* 2008 Oct 1;57(4):660–80.
- Greaves CJ, Farbus L. Effects of creative and social activity on the health and well-being of socially isolated older people: outcomes from a multi-method observational study. *J R Soc Promot Health* 2006 May 1;126(3):134–42. Repper 2011.
- Repper J, Carter T. A review of the literature on peer support in mental health services. *J Ment Health* 2011 Aug 1;20(4):392–411.
- Maheswaran H, Weich S, Powell J, Stewart-Brown S. Evaluating the responsiveness of the Warwick Edinburgh Mental Well-Being Scale (WEMWBS): group and individual level analysis. *Health Qual Life Outcomes* 2012;10:156.
- Stewart-Brown S, Anthony R, Wilson L, Winstanley S, Simkiss D, Stallard N, et al. Should randomized controlled trials be the ‘gold standard’ for research on preventive interventions for children. *J Children's Serv* 2011;6:228–35. <http://dx.doi.org/10.1108/17466661111190929>.

28. Threlfall AG, Meah S, Fischer AJ, Cookson R, Rutter H, Kelly MP. The appraisal of public health interventions: the use of theory. *J Public Health* 2015;**37**:166–71.
29. Towey M, Harrell R, Lee B. Evaluation of “one body, one life”: a community-based family intervention for the prevention of obesity in children. *J Obes* 2011. <http://dx.doi.org/10.1155/2011/619643>.
30. National Institute for Health and Clinical Excellence. *Clinical guideline 43: obesity: guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children*. 2006. <https://www.nice.org.uk/guidance/cg43> (accessed: 2009), ISBN: 978-1-4731-0893-6.
31. Department of Health. ‘Choosing health: making healthy choices easier’ white paper. 2004. [http://webarchive.nationalarchives.gov.uk/+/dh.gov.uk/en/publicationsandstatistics/publications/publicationspolicyandguidance/dh\\_4094550](http://webarchive.nationalarchives.gov.uk/+/dh.gov.uk/en/publicationsandstatistics/publications/publicationspolicyandguidance/dh_4094550) (accessed 2009).
32. Cavill N, Hillsdon M, Anstiss T. *Brief interventions for weight management*. Oxford: National Obesity Observatory; 2011. [http://www.noo.org.uk/uploads/doc/vid\\_10702\\_BIV2.pdf](http://www.noo.org.uk/uploads/doc/vid_10702_BIV2.pdf) (accessed 20 April 2011).
33. Crosby RD, Kolotkin RL, Williams GR. Defining clinically meaningful change in health-related quality of life. *J Clin Epidemiol* 2003;**56**:395–407.
34. Erdfelder E, Faul F, Buchner A. GPOWER: a general power analysis program. *Behav Res Methods Instrum Comput* 1996;**28**:1–11.
35. Roberts K, Cavill N, Rutter H. National obesity observatory. *Stand Eval Framew Weight Manag Interv* 2009. [www.noo.org.uk/sef](http://www.noo.org.uk/sef).
36. Clarke A, Friede T, Putz R, Ashdown J, Martin S, Blake A, et al. Warwick-Edinburgh Mental Well-being Scale (WEMWBS): validated for teenage school students in England and Scotland. A mixed methods assessment. *BMC Public Health* 2011;**11**(1):487.
37. Gremigni P, Stewart-Brown S. Measuring mental well-being: Italian validation of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS). *G Ital Psicol* 2011;**38**:485–508.
38. Castellví P, Forero CG, Codony M, Vilagut G, Brugulat P, Medina A, et al. The Spanish version of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) is valid for use in the general population. *Qual Life Res* 2013;**23**:1–12.
39. Bridges S. Chapter 5: wellbeing. In *Health survey for England*. Craig R, Mindell J 2013. [www.hscic.gov.uk/pubs/hse2012](http://www.hscic.gov.uk/pubs/hse2012) (accessed 6 July 2013).
40. Oyebo O, Gordon-Dseagu V, Walker A, Mindell JS. Fruit and vegetable consumption and all-cause, cancer and CVD mortality: analysis of health survey for England data. *J Epidemiol Community Health* 2014;**68**(9):856–62.
41. IBM Corp Released. *IBM SPSS statistics for windows, version 22.0*. Armonk, NY: IBM Corp; 2013.
42. Field A. *Discovering statistics with SPSS*. London: Sage; 2005.
43. Cohen JA. Power primer. *Psychol Bull* 1992;**112**:155–9.
44. Penedo FJ, Dahn JR. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr Opin Psychiatry* 2005;**18**:189–93.
45. Stathopoulou G, Powers MB, Berry AC, Smits JAJ, Otto MW. Exercise interventions for mental health: a quantitative and qualitative review. *Clin Psychol Sci Pract* 2006;**13**:179–93.
46. Kirkwood T, Bond J, May C, McKeith I, Teh M. *Foresight mental capital and wellbeing project. Mental capital through life future challenges*. 2008.
47. Rees K, Hartley L, Flowers N, Clarke A, Hooper L, Thorogood M, et al. ‘Mediterranean’ dietary pattern for the primary prevention of cardiovascular disease. *Cochrane Database of Systematic Reviews* 2013;(8). Article number CD009825.
48. Iriti M, Varoni EM. Melatonin in Mediterranean diet, a new perspective. *J Sci Food Agric* 2015 Sep 1;**95**(12):2355–9.
49. Wang X, Ouyang Y, Liu J, Zhu M, Zhao G, Bao W, et al. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ* 2014.
50. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. *N Engl J Med* 2001 Jan 4;**344**(1):3–10.
51. Carr AC, Bozonet SM, Pullar JM, Vissers MC. Mood improvement in young adult males following supplementation with gold kiwifruit, a high-vitamin C food. *J Nutr Sci* 2013;**2**:e24.
52. Conner TS, Brookie KL, Richardson AC, Polak MA. On carrots and curiosity: eating fruit and vegetables is associated with greater flourishing in daily life. *Br J Health Psychol* 2015 May 1;**20**(2):413–27.
53. Smith AP, Rogers R. Positive effects of a healthy snack (fruit) versus an unhealthy snack (chocolate/crisps) on subjective reports of mental and physical health: a preliminary intervention study. *Front Nutr* 2014;**1**.
54. Rolls BJ, Ello-Martin JA, Tohill BC. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutr Rev* 2004 Jan 1;**62**(1):1–7.
55. Upton D, Upton P, Bold J, Peters DM. *Regional evaluation of weight management programmes for children and families. Report commissioned by the Department of Health West Midlands*. 2010.
56. Streiner DL. Missing data and the trouble with LOCF. *Evid Based Ment Health* 2008;**11**(1):3–5.
57. Sterne JAC, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ* 2009;**338**:b2393.
58. Macdiarmid J, Blundell J. Assessing dietary intake: who, what and why of under-reporting. *Nutr Res Rev* 1998;**11**:231–54.
59. Adams SA, Matthews CE, Ebbeling CB, Moore CG, Cunningham JE, Fulton J, et al. The effect of social desirability and social approval on self-reports of physical activity. *Am J Epidemiol* 2005;**161**:389–98.
60. Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *Int J Behav Nutr Phys Act* 2008;**5**:56.