

Transforming Diet in the Workplace: Effectiveness of a Stage of Change–Based Dietary Intervention for Sedentary Office Workers in Southern Sri Lanka – A Cluster Randomised Trial

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Abstract

Background

An unhealthy diet is a key risk factor for increasing non-communicable diseases (NCDs) among office workers and causes a significant health and economic burden. Interventions based on the stage of change theory are becoming more effective, and the effectiveness of dietary interventions in office workers remains to be established. The current study assessed the effectiveness of a stage-matched intervention for dietary behaviour change among office workers.

Methods

A cluster-randomised trial was conducted in the Galle District, Sri Lanka. Intervention clusters received an intervention tailored to participants' Stage of Change (SOC) at baseline, whereas the control clusters received no intervention. The SOC and dietary intake were assessed at baseline and post-intervention through a staging algorithm and a 24-hour dietary recall, supplemented by a picture guide and computer software. At the end of three months, changes in the stage of change (primary outcome) and in healthy dietary intake (secondary outcome) were compared between the intervention and control groups using univariate and logistic regression analyses, with a p-value cut-off of 0.05.

Results

A positive change in SOC was observed in both the control ($p = 0.04$) and intervention ($p < 0.001$) groups. The intervention group showed significant improvements in cereal, fruit, and vegetable intake and a reduction in unhealthy food intake ($p < 0.001$). The intervention was a significant predictor of both primary ($OR = 12.2$, $p < 0.001$) and secondary ($OR = 25.3$, $p < 0.001$) outcomes. Being a clerical worker ($OR = 1.7$, $p = 0.05$) and being in action or maintenance stages at baseline ($OR = 3.5$, $p < 0.001$) were significant predictors of primary and secondary outcomes, respectively.

Conclusions and recommendations:

The stage-matched dietary intervention was effective in achieving a change in stage of change and towards a healthy diet. We recommend further studies to assess the intervention's effectiveness in a more pragmatic manner across different settings.

Trial registration

The trial was registered in the Sri Lanka Clinical Trial Registry (Registration No. SLCTR/2020/025, Date 15/12/2020)

Background

An unhealthy diet can be defined as a diet that contains high amounts of energy with or without any other harmful ingredients, and low amounts of nutrients ¹. It is among the key risk factors associated with non-communicable diseases (NCDs), leading to a significant amount of mortality and morbidity ².

An office worker is defined as 'an employee who works in an office, especially one engaged in clerical or administrative work' ³. Several reviews and studies have highlighted a higher prevalence of unhealthy dietary practices among office workers, such as low fruit and vegetable consumption, high salt intake and practices like consumption of pre-cooked food and takeaway food, and missing meals ⁴⁻⁶. Adding more to the issue, office workers are found to be less active during both working and off-hours ^{5, 7, 8}.

Non-communicable diseases account for 75% of the deaths in Sri Lanka. Unhealthy dietary intake has been the most prevalent risk factor for NCD among Sri Lankans in general ⁹. Several studies have shown a high carbohydrate intake among office workers in Sri Lanka ^{10, 11}. An unhealthy diet in combination with lesser physical exertion at work makes office workers more vulnerable to NCDs. Therefore, to achieve the Sustainable Development Goal target of reducing premature mortality in Sri Lankans by 2030, it is essential to prevent the occurrence of NCDs by reducing the prevalence of risk factors in this population through suitable interventions.

Office hours can influence workers' dietary intake and behaviour, as they consume one or two main meals and snacks during the time ¹². On the other hand, a group sharing similar characteristics are gathered in one place, enhancing the feasibility of delivering and evaluating the effectiveness of an intervention ³. A recent review identified 14 randomised controlled trials and 11 other types of research targeted at dietary behavioural change in office workers ³. However, the same review concluded that evidence regarding the effectiveness of dietary interventions in office settings is inconclusive. Apart from a few isolated health promotional interventions ¹³, there were no studies conducted to assess the effectiveness of dietary intervention for office workers in Sri Lanka.

The stage of change theory is the most dominant stage theory used in health interventions ¹⁴. There, behaviour change is described in five stages: pre-contemplation, contemplation, preparation, action, and maintenance as the phases through which an individual can pass in changing his or her behaviour ¹⁵. In addition, ten processes of change have been identified as enablers for progress through the stages of change ¹⁵. Though the stage of change theory was believed to be effective in alcohol and smoking prevention, its effectiveness in dietary behaviour change interventions is yet to be established.

Although a substantial body of work has examined the effectiveness of dietary interventions, studies grounded in behavioural theories remain limited. The stage of change theory is an emerging approach for use in dietary intervention. Further, evidence on the effectiveness of dietary interventions and the factors influencing them in low- and middle-income countries is lacking in the global context. In this backdrop, our study aimed to assess the effectiveness of a dietary intervention based on stage of

change theory among office workers in the Galle district, Sri Lanka. We believe the current study's findings will enrich the local and global evidence on the effectiveness of a dietary intervention for office workers in low- and middle-income countries.

Methods

Study design

The study was a cluster-randomised trial in which clusters of office workers were randomly assigned to the control and intervention arms with allocation concealment, and individual-level outcomes were compared at the end of the 12-week trial period. Blinding was not incorporated into the study.

Study setting

Twenty government offices across an administrative district (Galle district) in the Southern Province of Sri Lanka were selected as study clusters.

Study population

Office workers engaged in office-based work and not physically exerting themselves during work hours (namely, development officers, management assistants, and administrative and management officers) were selected for the study. Workers on special dietary plans were excluded.

Sample size and sampling

Sample size was calculated based on the formula for estimating the proportion difference in cluster randomised trials ¹⁶. Assuming 30% and 45% of participants will have the outcome of interest in the control and intervention groups, respectively. After correction for the design effect (1.58) and the dropout rate (10%), the required sample size was 280 per arm.

A cluster was defined as an office with at least 30 office workers, and offices were purposively selected based on the number of workers, the nature of the work and adequate distance to minimise contamination. Participants were randomly selected from selected clusters, followed by an informed written consent process at the individual level. A detailed account of the sample size calculation and recruitment is published elsewhere ¹⁷.

Data collection tools and data collection

Two-point data collection was conducted at the baseline and after the intervention. Data collection tools comprised of three parts. 1. Self-administered questionnaire collected basic socio-demographic, general

health status, and selected dietary behaviour data, 2. staging algorithm that was adopted from the well-known '5 a day' project and a number of subsequent studies^{18–20} to ascertain the stage of change, 3. 24-hour dietary recall assisted by a picture guide and computer software to determine portion size and calculate serving number, respectively (supplementary file I). Participants' weight and height were measured according to standard procedures described in the European Health Examination Survey (EHES)²¹.

Data on basic socio-demographic variables and general health status were collected only at the baseline. The dietary intake and stage of change were assessed at baseline and post-intervention.

Randomisation and allocation concealment

The selected clusters were randomised into two arms after baseline data collection to minimise observer bias. All selected clusters (n = 20) were randomised using an online randomisation sequence generator into two groups of 10 offices, and the two groups were then randomly assigned to the intervention and control groups using the lottery method. The randomisation sequence was generated, and the offices were allocated to two arms in accordance with the allocation concealment procedure. The detailed randomisation and allocation concealment procedure is published elsewhere¹⁷. After randomisation, the intervention arm included 266 participants from 10 offices, and the control arm included 252 participants from 10 offices.

Intervention

Two sets of interventions were developed, considering the processes of change associated with each stage, as described by Prochaska & Velicer, who highlighted that the pre-contemplation and contemplation (early) stages require more consciousness-raising, dramatic relief, self-revaluation, and environmental re-evaluation and preparation, action, and maintenance (latter) stages require processes of change such as self-liberation, contingency management, helping relationships, counterconditioning, and stimulus control. Participants in the early stages were provided with information and an emotional and imaginative comparison between healthy and unhealthy behaviour. For the latter stages, a greater emphasis is placed on replacing unhealthy behaviour with healthy behaviour, monitoring whether the participant is on the right track, and ensuring environmental support¹⁵. Therefore, interventions to raise awareness and provide emotional arousal were designed for the pre-contemplation and contemplation stages, and interventions to support and monitor healthy behaviour were designed for the preparation, action, and maintenance stages. A detailed description of the stage-matched intervention has been published elsewhere¹⁷.

Control

No intervention was done for the control clusters. However, they participated in other health education and promotion programmes conducted by preventive health institutes and organisations (business as usual).

Assessment of adherence to the intervention

Either attendance at the physical lectures or receiving feedback within five days for narrated lectures, provided to participants who did not attend, was recorded as adherence. Not marking the serving counter for more than two days per week in a given month was considered non-adherence.

Primary outcome and determination of the stage of change

Progression from a lower to a higher stage of change was defined as the primary outcome of the intervention. The first question of the staging algorithm was modified to specify a healthy change in dietary intake, and the participant's reported stage of change was coupled with the 24-hour dietary recall. This approach was suggested and used in previous studies to determine a more precise stage of change in nutrition research, based on the stage of change theory^{22–26}. A detailed description and the rationale for using the above approach for stage of change determination have been included in the protocol for the current study, published elsewhere¹⁷.

Secondary outcome

The secondary outcome was a change from an unhealthy to a healthy diet or persistence in a healthy diet. An operational definition that has been repeatedly used by the research team was used to define a healthy diet: “adherence to the recommended servings in the FBDG for Sri Lankans for more than three food groups, including cereal and cereal-based foods and the fruits, and vegetables, with the consumption of one or no unhealthy food per day”^{17, 27, 28}. The recommended servings from different food groups per day are shown in Table 1.

Table 1
Recommended numbers of servings from different food groups per day

1	Food group	No. of servings
	Rice, bread, other cereals and yams	6–7 (6 -11^a)
2	Fruits	2–3
3	Vegetables	3–5
4	Milk and / or milk products	1–2
5	Fish, pulses, meat and eggs	3–4
6	Nuts and oil seed	2–4

^a wider range has been given to the food group rice, bread, other cereals, and yams in the FBDG as the energy requirement differs with the activity level and the sex. Because office workers were considered a sedentary group, 6–7 servings of rice, bread, other cereals, and yams food group was considered as the recommended numbers of servings based on expert opinion

The FBDG for Sri Lankans recommends selecting a variety of food items from each food group and consuming the specified number of servings as outlined in Table 3. However, considering the typical Sri Lankan diet, we consider three food groups, including the two commonly consumed and important food groups (“Rice, bread, other cereals and yams” and “vegetables and fruits”) and an additional food group for protein intake from “fish, pulses, meat and eggs” or “milk and milk products”, to be essential for a healthy diet. Additionally, we include a limit for unhealthy foods (those containing only sugar and fat, as well as highly processed foods) in the definition of a healthy diet.

Statistical analysis

Sample characteristics were described in relation to socio-demographic, health and work-related factors, and adherence to the intervention using descriptive statistics.

Achieving and not achieving the outcomes (primary and secondary) were coded as “1” and “0” respectively. The effectiveness of the intervention was determined at the end of the 12-week period by comparing the proportions achieving the intended outcomes within and between the intervention and control groups. The exact McNemar test was used to assess the statistical significance of associations.

A basic multilevel logistic regression model was used to assess clustering effects on the primary and secondary outcomes at baseline. As the variance of the intercept was very low and not statistically significant in the random-effects model, and the number of clusters for the study was small, the clustering effect was assumed to be minimal. Therefore, binary logistic regression was performed to assess the intervention's effectiveness. All factors that showed a statistically significant association with achieving the outcome, as well as those known to be associated with intervention effectiveness based on existing evidence, were included in the logistic regression model to assess the intervention's effectiveness. The forward selection method was used to include variables in the model, and the

goodness of fit was assessed using the Hosmer-Lemeshow test and the model's R-squared value. All analyses were performed using the Statistical Package for the Social Sciences (SPSS) software (Version 27), and a p-value < 0.05 was considered statistically significant.

Ethical and administrative clearance

The study was conducted in accordance with the World Medical Association Declaration of Helsinki on ethical principles for medical research involving human subjects. The study's ethical conduct was approved by the Ethics Review Committee, Faculty of Medicine, University of Ruhuna (Registration No. 2020/P/105) and the trial was registered in the Sri Lanka Clinical Trial Registry (Registration No. SLCTR/2020/025, date 15/12/2020).

Administrative approval was obtained from all relevant authorities. Informed written consent was obtained from all office workers prior to data collection. Workers identified with health problems were referred to Teaching Hospital Karapitiya and to Base Hospitals Udugama, Elpitiya, or Balapitiya, as per their preference.

Results

There were 650 workers on the payroll in the selected offices, and 610 of them were randomly selected and invited to participate in the study. Among them, 518 consented to participate, and following cluster randomisation, 252 and 266 participants were included in the control and intervention arms, respectively. The consort diagram describes the flow of participants through the intervention and post-intervention data analysis (Fig. 1).

Most of the characteristics were evenly distributed between the intervention and control groups. However, there were a few characteristics, such as sex, marital status, income level and a family history of NCD that showed significant differences between the two groups. Table 2 describes the sample characteristics of the two groups.

Table 2
Characteristics of the participants in intervention and control groups

Characteristics	Control group No. (%)	Intervention group No. (%)	Total No. (%)	Significance [#]
Age				
Median* and below	153 (60.7)	167 (62.8)	320 (61.8)	$\chi^2 = 0.23$ p = 0.62
Above median	99 (39.3)	99 (37.2)	198 (38.2)	
Sex				
Male	31 (12.3)	63 (23.7)	94 (18.1)	$\chi^2 = 11.29$ p < 0.001
Female	221 (87.7)	203 (76.3)	424 (81.9)	
Education level				
Up to GCE (A/L)	109 (43.3)	102 (38.3)	211 (40.7)	$\chi^2 = 1.29$ p = 0.26
Tertiary education	143 (56.7)	164 (61.7)	307 (59.3)	
Monthly income ^a				
Median** and below	98 (53.3)	132 (65.3)	230 (59.6)	$\chi^2 = 5.84$ p = 0.02
Above median	86 (46.7)	70 (34.7)	156 (40.4)	
Married				
Yes	221(87.7)	215 (80.8)	436 (84.2)	$\chi^2 = 4.59$ p = 0.03
No	31 (12.3)	51 (19.2)	82 (15.8)	
Number of living children				
0	52 (20.6)	73 (27.4)	125 (24.1)	$\chi^2 = 3.37$ p = 0.19
1 to 2	37 (14.7)	38 (14.3)	75 (14.5)	
> 2	163 (64.7)	155 (58.3)	318 (61.4)	
Post held				
Clerical	172 (68.3)	196 (73.7)	368 (71.0)	$\chi^2 = 1.86$ p = 0.17
Other	80 (31.7)	70 (26.3)	150 (29.0)	
^a n=386, 132 missing; ^b n=513, 5 missing; ^c n=511, 7 missing; ^d n=514, 4 missing; ^e n=502, 16 missing; ^f n=516, 2 missing; [#] Chi square test; *median age = 39.5years; **median income = 70,000 Sri Lankan Rupees				

Characteristics	Control group No. (%)	Intervention group No. (%)	Total No. (%)	Significance [#]
Age				
Travel duration^b				
< 30min	148 (59.2)	140 (53.2)	288 (56.1)	$\chi^2 = 2.27$
30-60min	75 (30.0)	95 (36.1)	170 (33.1)	$p = 0.32$
> 60min	27 (10.8)	28 (10.6)	55 (10.7)	
BMI				
Low or normal	153 (60.7)	168 (63.2)	321 (62.0)	$\chi^2 = 0.33$
Overweight or obese	99 (39.3)	98 (36.8)	197 (38.0)	$p = 0.57$
Having personal history of NCD^c				
Yes	33 (13.3)	26 (9.0)	59 (11.5)	$\chi^2 = 1.46$
No	215 (86.7)	237 (90.1)	452 (88.5)	$p = 0.27$
Having family history of NCD^d				
Yes	176 (70.4)	157 (59.5)	333 (64.8)	$\chi^2 = 6.72$
No	74 (29.6)	107 (40.5)	181 (35.2)	$p = 0.01$
Having meals in groups^e				
Yes	164 (67.8)	174 (66.9)	338 (67.3)	$\chi^2 = 0.14$
No	78 (32.2)	86 (33.1)	164 (32.7)	$p = 0.85$
Having snacks^f				
Yes	137 (56.4)	143 (54.0)	280 (54.3)	$\chi^2 = 0.02$
No	114 (45.4)	122 (46.0)	236 (45.7)	$p = 0.88$
^a n=386, 132 missing; ^b n=513, 5 missing; ^c n=511, 7 missing; ^d n=514, 4 missing; ^e n=502, 16 missing; ^f n=516, 2 missing; [#] Chi square test; *median age = 39.5years; **median income = 70,000 Sri Lankan Rupees				

Following the intervention, both the control and intervention clusters showed a statistically significant change in the stage of change. However, the extent and the pattern of the change showed marked differences between the two groups. In the control group, the change was minimal and limited to the early stages, such as pre-contemplation, contemplation, and preparation. It showed a slight reduction in

the pre-contemplation and contemplation stages, and a slight increase in the preparation stage, while the action and maintenance stages remained unchanged. In contrast, changes were marked in the intervention group, where a significant reduction was noted in the early stages, such as pre-contemplation, contemplation, and preparation, while the action and maintenance stages showed a marked increase following the intervention. Figure 2 shows the change in stage of change from baseline to post-intervention among participants in the two study arms.

Statistically significant changes towards the intake of the recommended number of servings were observed in the intervention group. A reduction in cereal-based food consumption (from 6.4 to 5.9 servings) and an increase in fruit and vegetable consumption (from 3.7 to 4.4 servings) was observed in the intervention group. Further, consumption of unhealthy food was also reduced (from 2.2 to 1.5 servings). However, there were no significant changes in the consumption of fish, meat, pulses, and dairy products. The control group did not show significant changes in consumption in any of the food groups. Table 3 describes the changes in consumption in each food group following the intervention in the intervention and control groups.

The univariate analysis showed a highly significant association between the intervention and the achievement of both primary and secondary outcomes. While 62.0% (n = 132) of participants in the intervention group achieved a progressive change in stage of change (primary outcome), only 11.2% (n = 22) of participants in the control group did so. Similarly, 38.7% (n = 85) of participants in the intervention group changed to a healthy diet, compared with only 2.7% (n = 6) in the control group. Further, being a clerical worker and being in an early stage of change were associated with achieving progressive change in the stage of change. In contrast, being in a later stage of change was associated with a shift towards a healthy diet. The detailed results of the univariate analysis are shown in Supplementary File II.

The basic mixed model showed between-cluster variances of 0.20 and 5.9×10^{-10} for the primary and secondary outcomes, respectively, and intraclass correlation coefficients of 0.05 and 21.79×10^{-10} . As this indicates minimal clustering effects for both outcomes, binary logistic regression was used for further analysis. It revealed that only the intervention (OR = 12.2, 95%CI: 7.2–20.9, $p < 0.001$) and being a clerical worker, compared to a managerial or administrative worker (OR = 1.7, 95%CI: 1.0–2.9, $p = 0.05$), were identified as significant predictors of achieving a progressive change in stage of change. Intervention (OR = 25.3, 95% CI: 10.5–61.1, $p < 0.001$) and being in the action or maintenance stages (OR = 3.5, 95% CI: 2.1–6.0, $p < 0.001$) were significant predictors of change from an unhealthy to a healthy diet. Table 4 presents the results of multiple logistic regression for achieving the primary and secondary outcomes. None of the other variables showed significant independent associations with either the primary or secondary outcomes.

Table 3
Change of food intake following the intervention in the intervention and control groups

Food group	Mean daily intake of the servings					
	Intervention Group			Control Group		
	Pre-intervention Mean (SD)	Post intervention Mean (SD)	p-value	Pre-intervention Mean (SD)	Post intervention Mean (SD)	p-value
Cereal-based foods	6.4 (2.6)	5.9 (2.2)	< 0.001	5.7 (2.1)	5.7 (1.9)	0.93
Vegetables	3.0 (1.6)	3.3 (1.5)	0.001	2.5 (1.4)	2.5 (1.4)	0.34
Fruits	0.7 (0.9)	1.1 (1.0)	< 0.001	0.7 (1.0)	0.7 (1.0)	0.56
Fish, meat, pulses	3.4 (2.0)	3.4 (1.9)	0.427	3.7 (2.3)	3.9 (2.4)	0.08
Dairy products	0.7 (0.8)	0.7 (0.8)	0.701	0.7 (0.8)	0.8 (0.9)	0.65
Unhealthy foods	2.2 (1.5)	1.5 (1.3)	< 0.001	1.9 (1.4)	1.9 (1.3)	0.64

Table 4

Multivariate analysis of factors associated with the achievement of primary and secondary outcomes

Variables	B (SE)	Odds ratio (95% CI)	p-value
Progressive change in stage of change (Primary outcome)^a			
Having the intervention	2.51 (0.27)	12.2 (7.2–20.9)	< 0.001
Being a clerical worker	0.52 (0.27)	1.7 (1.0-2.9)	0.05
Constant	-2.42 (0.31)		< 0.001
Change to a healthy dietary intake (Secondary outcome)^b			
Having the intervention	3.23 (0.45)	25.3 (10.5–61.1)	< 0.001
Being in the action or maintenance stage	1.26 (0.27)	3.5 (2.1-6.0)	< 0.001
Constant	-2.42 (0.31)		< 0.001
<i>Note: ^aR² = 0.26 (Cox & Snell), 0.35 (Nagelkerke), Hosmer and Lameshow test: Chi square = 6.98 (p-value = 0.03)</i>			
<i>^bR² = 0.24 (Cox & Snell), 0.36 (Nagelkerke), Hosmer and Lameshow test: Chi square = 4.8 (p-value = 0.09)</i>			

Discussion

This study was conducted to assess the effectiveness of a stage-based intervention to change dietary intake among office workers in the Galle district, Sri Lanka. Stage-matched interventions were implemented for three months, and progressive change in stage of change and change to a healthy diet were assessed as primary and secondary outcomes. It was observed that the intervention was effective in achieving the primary and secondary outcomes compared to the control. Furthermore, being a clerical worker, compared to a managerial or administrative worker, and being in the action or maintenance stage, compared to other stages, were associated with achieving primary and secondary outcomes, respectively.

The study sample resembles the target population in many factors, such as education status, methods of travelling to work, BMI and NCD prevalence according to previous surveys and studies in general^{10, 29}. A few discrepancies in baseline characteristics, such as sex, monthly family income and family history of NCD, were noted between the control and intervention groups. This can be a limitation in a cluster randomised design, as the randomisation is done at the cluster level rather than at the individual level, as in randomised controlled trials. This could have been addressed by stratified randomisation and by incorporating a multivariate analysis^{30, 31}. In the current study, similar offices were selected to ensure comparability between the two arms, and all unevenly distributed variables were individual characteristics. Therefore, it was impossible to apply stratified randomisation. However, stratified and

multivariate analyses were incorporated into the final analysis of factors associated with the achievement of primary and secondary outcomes in the study to identify and control for baseline discrepancies in sample characteristics.

There was a significant improvement in the stage of change in both intervention and control groups (Fig. 2). However, the pattern of change in the stage of change differed between the two groups. While slight changes were noted in the early stages of change (pre-contemplation, contemplation, and preparation) in the control group, the intervention group showed a marked increase in the later stages of change (action and maintenance). Furthermore, the improvement in stage of change in the intervention arm was highly significant compared to that of the control group. This suggests a more specific effect on achieving progressive change in the stage of change from the intervention. The progressive change in the control group can be explained in two mechanisms. First is the Hawthorne effect, in which study participants tend to behave more healthily when they are observed. Second, we have not advised the control group to refrain from participating in other routine health education or promotion activities. Those might have contributed to this minimal change as well. However, interventions based on stage of change theory are known to achieve progressive change in the stage of change. A study among young adults in Sri Lanka has demonstrated a progression through the stages of change, even though the intervention was not stage-tailored³². A large-scale study aimed at promoting healthy behaviours among workers across different work sites has also concluded that the intervention facilitated a progressive change in workers' stage regarding healthy dietary intake³³. A recent study conducted among adolescents in Turkey implemented stage-matched health promotion interventions and demonstrated widening of the action and maintenance groups and narrowing of the pre-contemplation, contemplation, and preparation groups, findings similar to those of the current study³⁴. The current study reconfirms previous findings on achieving progressive change in the stage of change, with a strong emphasis on considering it when developing health education and promotional interventions.

Dietary intake in the control group changed to meet the recommended levels for cereal and cereal-based products, vegetables, fruits, and unhealthy foods. However, there was no significant change in intake of other food groups at pre- or post-intervention. Several systematic reviews have demonstrated the effectiveness of stage-matched interventions for a wide range of behaviours, including dietary intake, physical activity and addiction control^{35, 36}. Fruits and vegetables, fats, and junk foods were commonly addressed as dietary behaviours, while few studies assessed overall healthy dietary intake. One similar interventional study conducted among schoolchildren achieved a 71.5% reduction in low fruit and vegetable consumption, with a 19.6% reduction in obesity³⁷. Therefore, the current study further establishes the effectiveness of stage-of-change-based interventions in achieving healthy dietary intake, despite socio-cultural differences. However, some food groups, such as fish, meat, pulses, and dairy products, did not show a significant change. This can be attributed to the low consumption of nuts and seeds in the routine Sri Lankan diet. On the other hand, mean fish, meat, and pulse intake was within the recommended range prior to the intervention, which might explain the lack of a significant change in that food group.

The effectiveness of an intervention depends on multiple factors, both intrinsic to the intervention and extrinsic³⁸. Although factors such as age, gender, and other health and working conditions have been evaluated for their association with the effectiveness of the intervention, the current study identified that only being a clerical worker (as opposed to managerial or administrative workers) and the stage of change at baseline were associated with the effectiveness of the intervention in achieving the outcomes. This pattern was identical in both univariate and multivariate analyses, indicating minimal influence of confounding factors on the observed results. Further, both logistic regression models for the primary and secondary outcomes could predict more than 35% of outcomes.

Several studies have concluded that socio-demographic factors like age, gender, income and educational level were associated with the effectiveness of interventions^{38–40}. However, the current study failed to establish such associations with the intervention's effectiveness. This could be anticipated, as the variance of those characteristics was minimal among the current study participants, who included a similar set of workers. Since this study aimed to assess the effectiveness of the intervention, rather than the factors associated with it, minimal variance among work settings and workers was preferred to ensure comparability between the intervention and control groups. Therefore, the influence of socio-demographic factors on the effectiveness of the intervention would be better appraised when the intervention is applied to a wide range of people in a more pragmatic study design.

Being a clerical worker was independently associated with achieving a progressive change in the stage of change compared to managerial and administrative workers. There were hardly any studies in the global literature comparing the effectiveness of interventions across worker categories. However, a study assessing readiness to change in six lifestyle domains, including nutrition, among shift and non-shift healthcare workers, found no difference between the two groups⁴¹. Further, higher education levels and ranks among military workers have been associated with increased participation in behaviour change intervention studies, but there was no difference in achieving the intended outcomes⁴². The current study included more clerical workers because they comprise the majority of the office workers. They might have developed networks that can support behaviour change through supportive relationships and environments, compared with the smaller number of managerial and administrative workers⁴³. However, a detailed analysis of these influencing factors is beyond the scope of this study, and further studies are required to conduct an in-depth assessment of the factors associated with intervention effectiveness.

Despite the plausibility of the argument that participants in higher stages of change have greater intention to change behaviour, existing evidence on the effect of the initial stage of change on achieving intervention outcomes is inconclusive. Some studies have concluded that being in the action and maintenance stages facilitates the achievement of the intervention outcome^{33, 44}, whereas others claim that there was no significant impact of the initial stage of change on the achievement of the outcome^{43, 45}. However, adding to existing evidence, the current study highlights a positive association between being in the action and maintenance stages and change towards a healthy diet.

The study design itself is a strength of the current study, as the cluster-randomised trial design helps minimise contamination of the intervention. On the other hand, randomisation with allocation concealment minimised biases that would have been introduced during the allocation of control and intervention clusters. The offices selected for the study were scattered throughout the Galle district to ensure good representation of office workers, favouring the generalisation of the findings.

However, the lack of baseline comparability was a weakness of the current study. We believe it was reasonably ruled out during the analysis phase using stratified and multivariate analyses. Furthermore, the analysis did not account for clustering effects due to the small number of clusters and a low ICC in the study. This would not have completely eliminated the clustering effect. However, we believe the clustering effect is minimal, as offices were selected based on similarities in worker numbers and the nature of the work. The study lasted only 12 weeks due to feasibility issues, which may have prevented some participants from achieving outcomes, as dietary change may require a reasonable time to establish. On the other hand, the current study does not assess factors such as supportive relationships and the environment associated with the intervention aimed at changing dietary intake.

Conclusions and recommendations

The study concluded that the stage-matched dietary intervention, based on the stage of change theory, was effective in achieving a progressive change in stage of change and a transition from an unhealthy to a healthy diet. The initial stage of change was significantly associated with the shift from an unhealthy to a healthy diet.

We recommend further studies to assess the factors associated with the implementation and effectiveness of the intervention in more pragmatic settings, with the inclusion of different types of office communities. Further, we recommend developing dietary interventions tailored to an individual's stage of change and other constructs that can interfere with the success of intervention.

List of abbreviations

BMI Body Mass Index

CI Confidence Interval

EHES European Health Examination Survey

FBGD Food Based Dietary Guidelines

FBDG-SL Food Based Dietary Guidelines for Sri Lankans

GBD Global Burden of Disease

GCE General Certificate of Education

NCD Non-Communicable Disease

SD Standard Deviation

SOC Stage of Change

WHO World Health Organisation

Declarations

Ethics approval and consent to participate

Ethical approval for the study was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Ruhuna (Registration No. 2020/P/105). The trial was registered in the Sri Lanka Clinical Trial Registry (Registration No. SLCTR/2020/025). Administrative approval was obtained from all relevant authorities (District Secretariat, Galle District, Provincial Ministry of Local Government, and Regional Director of Health Services Office, Galle District). Informed written consent was obtained from all office workers before data collection. Workers identified with problems were referred to nearest healthcare facility with consent. Study was conducted in accordance with the World Medical Association Declaration of Helsinki on ethical principles for medical research involving human subjects.

Consent for publication

In the current study consent for publication is **not applicable** as no individual-level data with identification was included in the manuscript.

Competing interests

The authors declare that they have no competing interests.

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The study was self-funded by the corresponding author.

Author Contribution

JG planned the research project, data collection, statistical analysis and manuscript writing. CJW and MSDW provided technical guidance and supervised the research project. All authors read and approved the manuscript

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Data Availability

The datasets used and/or analysed during the current study are available from the following link.<https://drive.google.com/drive/folders/1YfzNhZCEtK88SGVSqmOpqrrTEr7FaOJR?usp=sharing>

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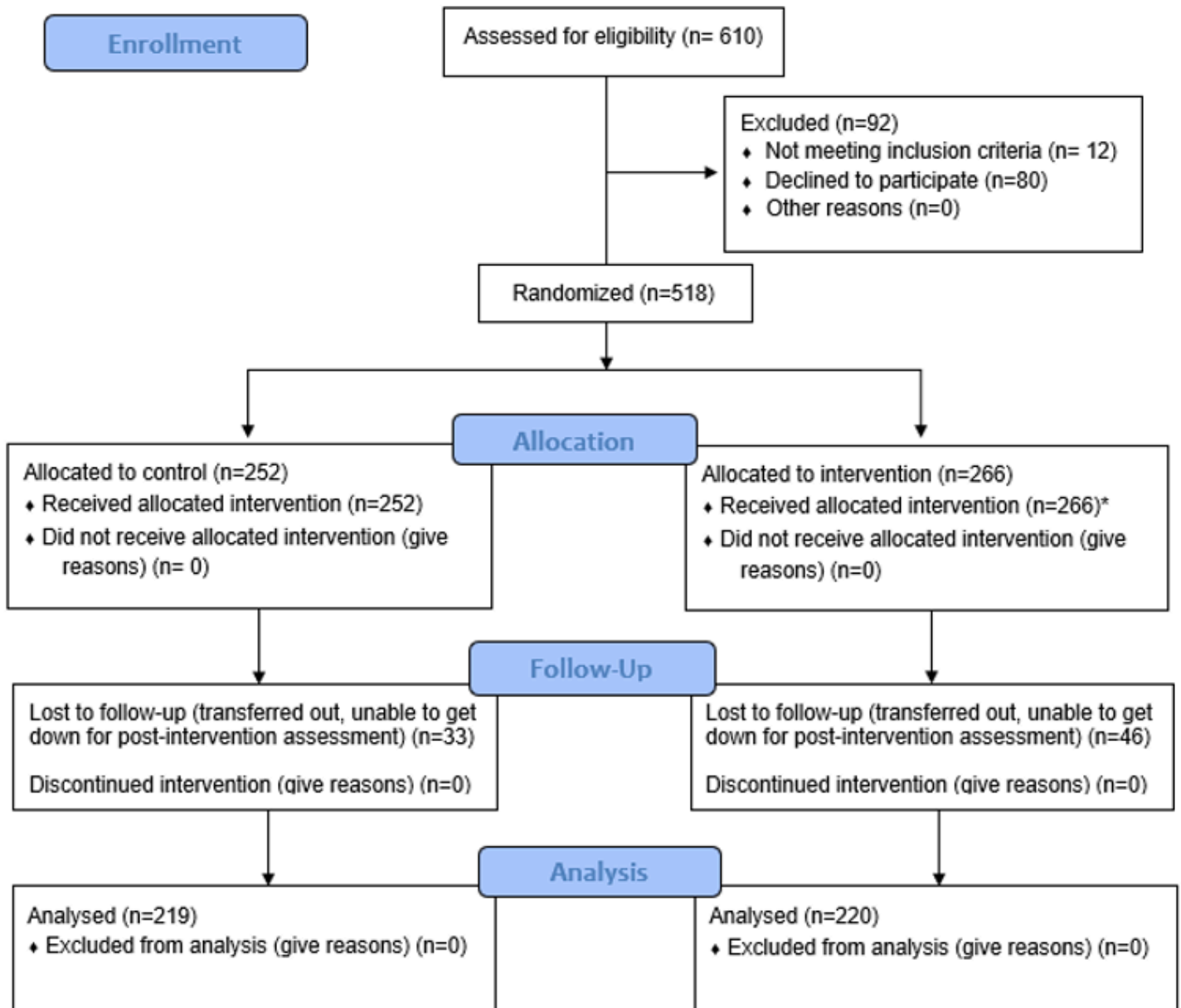
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Figures

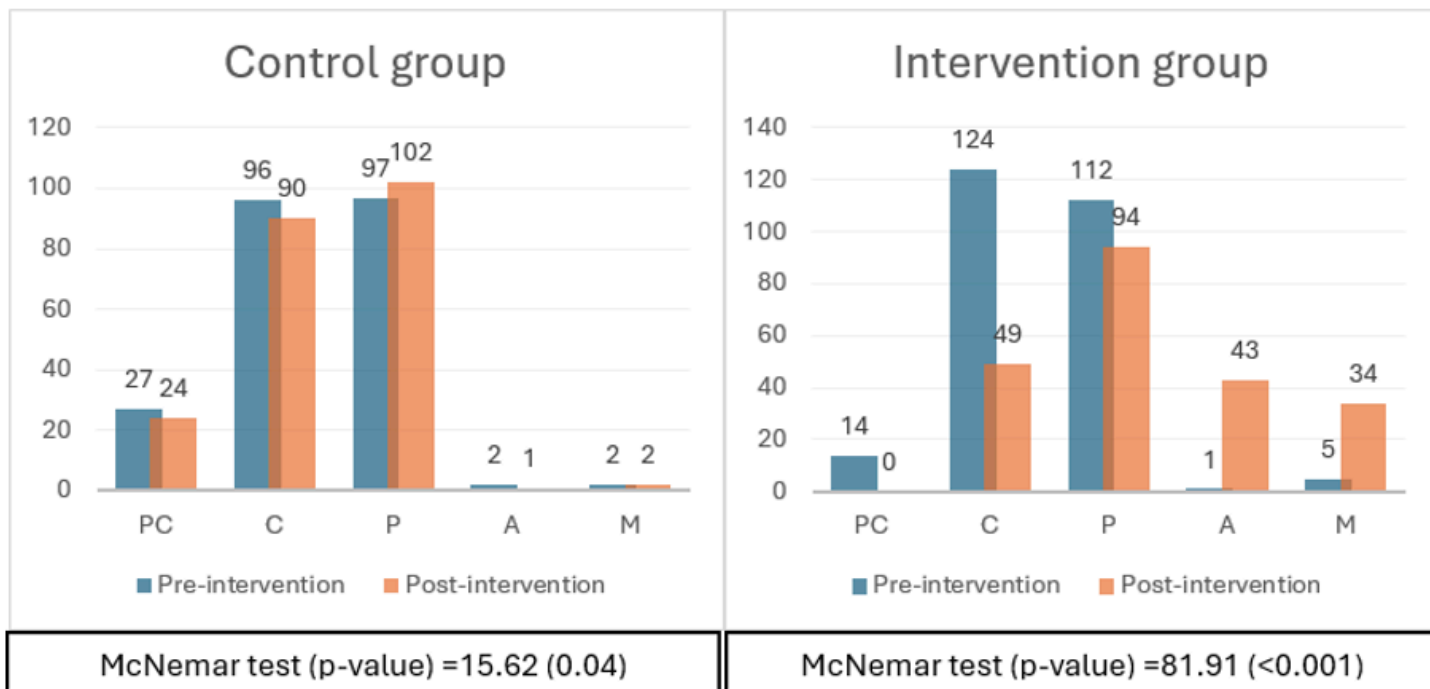
CONSORT 2010 Flow Diagram



*The intervention group was divided into two groups, depending on the participant's stage of change at the beginning. Two different interventions were implemented for each group. One group included 143 participants, and the other included 123 participants at the beginning and 127 and 97 at the end, respectively.

Figure 1

Consort flow diagram



PC: Pre-contemplation, C: Contemplation, P: Preparation, A: Action, M: Maintenance

Figure 2

Pre- and post-intervention difference of Stage of change in control and intervention groups

Supplementary Files

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