Section: Community Medicine

Original Research Article

MHEALTH IN MODIFYING DIET AND PHYSICAL ACTIVITY AMONG WOMEN GARMENT FACTORY WORKERS IN KOLAR: A RANDOMIZED CONTROLLED TRIAL

Sindhu Shankar S[1], Muninarayana C[2], Samudhyatha UC[3], Vivek Jayan[4]

[1]Assistant Professor, Department of Community Medicine, BGS Medical College and Hospital, Nagarur, Nelamangala, Adichunchanagiri University ACU, Bengaluru, India.
[2]Professor, Department of Community Medicine, Sri Devaraj Urs Medical College, SDUAHER, Tamaka, Kolar, Karnataka, India.
[3]Associate Professor, Department of Community Medicine, Sri Devaraj Urs Medical College, SDUAHER, Tamaka, Kolar, Karnataka, India.
[4]Assistant Professor, Department of Community Medicine, Saveetha Medical College and Hospitals, SIMATS, Thandalam, Chennai, Tamilnadu, India.

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Corresponding Author:
Dr Sindhu Shankar S
Assistant Professor, Department of Community Medicine, BGS Medical College and Hospital, Nagarur, Nelamangala, Adichunchanagiri University ACU, Bengaluru, India.562123
Email: kutti1617@gmail.com

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ABSTRACT

Background: India carries the largest global burden of non-communicable diseases (NCDs). The major modifiable risk factors for NCDs are unhealthy diet, physical inactivity, and alcohol and tobacco consumption. Medical and public health practices supported by mobile technologies are referred to as "mHealth." **Objective:** To assess the effectiveness of a 6-month mHealth package intervention in modifying diet and physical activity behaviours among women garment factory workers in Kolar district, Karnataka, India.
Materials and Methods: An open-label, parallel-group randomized controlled trial was conducted over 6 months. A total of 294 female garment factory workers were recruited and randomized into two equal groups — an Intervention Group (IG) and a Control Group (CG) — after baseline face-to-face counselling on healthy diet and physical activity. The IG received monthly telephonic counselling for six consecutive months. The outcome (change in diet and physical activity scores) was assessed six months after recruitment.
Results: Participants in both groups had similar scores at baseline. Diet scores in both the IG and CG improved substantially by the end of the trial but remained classified as "moderately healthy." At baseline, neither group had physical activity scores above 250 METs (Metabolic Equivalents); post-intervention, IG participants achieved improved MET scores.
Conclusion: Telephonic counselling was effective in improving dietary habits and physical activity, and was found to be feasible and acceptable.
Keywords: dietary habits; physical activity; mHealth; non-communicable diseases; METs; telephonic counselling.

INTRODUCTION

Globally, chronic non-communicable diseases (NCDs) are the leading cause of death, accounting for 41 million deaths annually — 74% of all fatalities worldwide. Around 17 million people die prematurely from NCDs before the age of 70, and 86% of these premature deaths occur in low- and middle-income countries (LMICs). Physical inactivity, poor eating habits, harmful alcohol use, and tobacco consumption increase the likelihood of dying from an NCD.[1]

In India, the four leading NCDs — diabetes, cancer, chronic respiratory diseases (CRDs), and cardiovascular diseases (CVDs) — are all on the rise, driven by the same four modifiable risk factors. The Indian Council of Medical Research (ICMR) report "India: Health of the Nation's States" (2017) documented that the proportion of mortality

attributable to NCDs increased from 37.9% in 1990 to 61.8% in 2016.[2]

Two complementary strategies are used for NCD prevention: an "at-risk" strategy, which targets individual-level risk-factor management, and a "population-based" strategy. Since diet is a common risk factor across most NCDs, individuals need education on nutrition, physical activity, and lifestyle habits such as alcohol and tobacco use.[3]

Under the National Health Mission, as part of Comprehensive Primary Health Care, India has implemented a population-based approach for the prevention, control, and early detection of common NCDs such as diabetes, hypertension, and common cancers, screening citizens aged 30 years and above.[2] Adults aged 30 and above are screened annually for hypertension and diabetes; those aged 30–65 years are additionally screened once every five years for breast, oral, and cervical cancers.[4]

"mHealth" refers to medical and public health practice supported by portable electronic devices such as mobile phones, patient-monitoring devices, and other wireless technologies. It spans simple voice calls and SMS through to more complex functionalities such as GPRS, GPS, and Bluetooth-enabled applications.

While mHealth interventions are increasingly used in urban populations, evidence on their development and application in rural India remains limited, particularly for specific occupational groups in LMICs — a gap also highlighted by a Cochrane review calling for more evidence on mHealth interventions.

The field has grown rapidly; prior studies show smartphones can support lifestyle interventions.[5] Smartphones have been in widespread use for roughly 13 years and have since been used to track health-related behaviours. With approximately 448.2 million mobile phone users and 73% mobile internet penetration in India, smartphone-based interventions using open-source applications may help bridge the gap between individuals' need for personalised NCD risk modification and the limited capacity of routine health services to provide this support.[6] A separate study found that two-thirds of mobile phone owners were willing to accept health-related voice calls.[7]

The WHO Global Plan of Action on Workers' Health emphasises that workplaces should promote, not merely protect, worker health.[8] Designing and testing an mHealth package for occupational groups, and assessing its feasibility, could support the development of low-cost interventions envisaged under India's National Programme for Prevention and Control of NCDs (NPNCD). This study aims to generate evidence on mHealth as such an intervention.

Objective

To assess the effectiveness of a 6-month mHealth package in modifying diet and physical activity behaviours among women garment factory workers in Kolar, Karnataka, India.

MATERIALS AND METHODS

Study Setting

The study was conducted among women employed at a single garment factory in Kolar (name withheld for ethical reasons), which employed 450 women at the time of the study. Employees worked a general shift from 8:30 a.m. to 5:30 p.m., with a half-hour lunch break, engaged in garment production using electrical machinery. An on-site medical facility staffed by a lady medical doctor and two nurses catered to employees' medical needs during working hours.

Study Design

An open-label, parallel-group randomized controlled trial.

Eligibility Criteria

Inclusion Criteria: Women aged over 18 years, owning a personal mobile phone, and employed on a permanent basis at the garment factory in Kolar.

Exclusion Criteria: Pregnant or lactating women; those planning to leave employment or retire within six months; those already enrolled in similar studies; physically challenged individuals; and those with a self-reported history of myocardial infarction, stroke, or psychiatric disorder.

Study Groups

Participants were randomized into two groups. Group A (Intervention Group, IG) received pamphlets detailing healthy dietary and physical activity practices plus a monthly mHealth package addressing healthy food intake and physical activity. Group B (Control Group, CG) received only the pamphlets.

Study Tools

A pre-tested, semi-structured questionnaire was used to collect:

- Socio-demographic details — age, income, marital status, locality, co-morbidities, tobacco use, and alcohol intake.
- Dietary habits — vegetable and fruit intake, dietary salt, processed food consumption, and knowledge of salt reduction, assessed using a modified version of a validated adherence questionnaire for diet and exercise in lifestyle-related diseases.[9]
- Physical activity — recreational physical activity, assessed using the WHO Global Physical Activity Questionnaire (GPAQ)[10] and quantified in Metabolic Equivalents (METs) using the Harvard T.H. Chan School of Public Health MET chart. MET reflects the body's energy expenditure; higher MET values indicate greater energy consumption for a given activity.

Study Duration and Approvals

The study was conducted from February 2021 to August 2022. The protocol was approved by the Institutional Ethics Committee (IEC) and prospectively registered with the Clinical Trials Registry of India (CTRI/2021/02/031569).

Sample Size

Assuming a 15% expected improvement in the intervention arm versus a 15% baseline rate of good dietary practice in the comparator group,[11] with 95% confidence, 80% power, and a 20% anticipated dropout rate, and a 1:1 allocation ratio, the minimum required sample size was calculated as 147 per group (294 total), using OpenEpi version 3.01.

Sampling and Randomization

Participants were recruited using simple random sampling. Randomization into Group A and Group B (1:1 allocation) was performed with the assistance of a biostatistics expert from the Department of Community Medicine, using a simple randomization technique. The allocation sequence was concealed in sealed, opaque envelopes and revealed only after baseline data collection was complete. Blinding was not feasible beyond this point due to the nature of the intervention.

Pilot Study

A pilot study involving six women garment workers was conducted in February 2021 to test and refine the questionnaire. These participants were excluded from the main study; their responses were used to validate the study tool.

Baseline Assessment

Following informed written consent, all participants were interviewed using the semi-structured questionnaire in April 2021, with baseline BMI, random blood sugar (GRBS), and blood pressure recorded using standard techniques. Both groups subsequently received the healthy-lifestyle pamphlets. Baseline data collection took one month.

Intervention

The mHealth package was a lifestyle-oriented telephone-delivered intervention. Individualised health-promotion counselling on diet and physical activity, based on each participant's baseline data, was delivered in the first month; this was designed with input from Community Medicine faculty, factory health staff, and worker stakeholders. Over the subsequent five months, one five-minute voice call per month assessed behaviour change and delivered individualised counselling following Social and Behavioural Change Communication (SBCC) model guidelines.[12] Calls were scheduled at each participant's preferred time, and any queries raised were addressed. If a call went unanswered, a second attempt was made after one hour; if still unanswered, the intervention was considered foregone for that month. Participants who missed two consecutive scheduled calls were classified as 'lost to follow-up' and excluded from the per-protocol analysis.

End-line Assessment

Six months after recruitment (November 2021), all participants in both groups were re-administered the dietary and physical activity questionnaires, with BMI, GRBS, and blood pressure re-measured using standard techniques.

Outcome Measures

The primary outcomes were change in dietary habits (increased vegetable and fruit consumption; reduced fried food and salt intake) and change in physical activity (MET score). Weight, random blood sugar, and blood pressure were also re-measured.

Statistical Analysis

Data were double-entered and validated in EpiData Entry Client v3.1, and analysed using IBM SPSS Statistics v20 and Stata v12. A difference-in-differences (DID) approach was used to assess intervention effectiveness, and the pre- to post-intervention change within and between groups was compared using the independent-samples t-test. A p-value < 0.05 was considered statistically significant.

RESULTS

The study included 290 female garment factory workers randomized into a Control Group (n = 145) and an Intervention Group (n = 145). Overall, 55.9% of participants were aged 30 years or younger and 44.1% were aged 31–60 years. Regarding marital status, 86.2% were married, 11.0% unmarried, 2.1% widowed, and 0.7% separated. By education, 77.2% had studied up to high school (class 12), 9.7% had post-high-school qualifications, 6.2% had additional post-high-school education, and 6.9% were illiterate. By occupation, 69.0% were skilled workers, 17.9% semi-skilled, 7.6% unskilled, and 5.5% semi-professional. Socio-economic status (SES), classified using the BG Prasad classification (May 2021),[13] showed 42.1% upper-middle class, 36.6% middle class, 16.6% lower-middle class, and 4.8% upper class. There was no statistically significant difference in the distribution of participants between the two groups at baseline.

Dietary Scores

Table 1 presents pre- and post-intervention dietary scores. Dietary scores were comparable between groups at baseline. Post-intervention, the mean dietary score was significantly higher in the Intervention Group than in the Control Group.

Table 1: Pre- and post-intervention dietary scores among Intervention and Control groups

Group	Pre-intervention			Post-intervention		
	N	Mean diet score (SD)	t (df), p	N	Mean diet score (SD)	t (df), p
IG	145	27.46 ± 4.39	t = -0.124 df = 288, p = 0.90	137	33.80 ± 5.68	t = 8.372 df = 259, p = 0.001*
CG	145	27.53 ± 5.05	--	124	28.49 ± 4.38	--

Table 2 stratifies dietary scores by age, education, occupation, and socio-economic status. Mean dietary scores did not differ significantly between groups at baseline for any sub-group. Post-intervention, participants in the Intervention Group aged ≤30 years and 31–60 years, those with high-school or post-high-school education, skilled and semi-professional workers, and those in SES Class II and III showed statistically significant improvement compared with their pre-intervention scores.

Table 2: Pre- and post-intervention dietary scores stratified by age, education, occupation, and socio-economic status

Sub-group	Group	Pre-intervention			Post-intervention		
		N	Mean (SD)	t (df), p	N	Mean (SD)	t (df), p
Age ≤30 yrs	IG	81	27.12 ± 3.55	t = -0.856 df = 153,p = 0.393	78	33.42 ± 5.57	t = 5.191 p = 0.001* df = 142
	CG	74	27.77 ± 5.69		66	28.80 ± 4.99	
Age 31-60 yrs	IG	64	27.90 ± 5.27	t = 0.739 df = 133, p = 0.46	59	34.29 ± 5.84	t = 6.858 p = 0.001* df = 115
	CG	71	27.29 ± 4.31		58	28.14 ± 3.56	
High school	IG	112	27.13 ± 3.85	t = 0.918 df = 207, p = 0.36	112	34.38 ± 4.58	t = 10.80 df = 197, p = 0.001*
	CG	97	26.64 ± 3.74		87	28.23 ± 3.04	
Post high school	IG	9	34.00 ± 6.74	t = -0.36 df = 24, p = 0.972	9	41.11 ± 5.73	t = 2.830 df = 24, p = 0.005*
	CG	17	34.15 ± 8.53		17	33.65 ± 6.70	
Skilled	IG	26	26.26 ± 2.44	t = 0.301 df = 41, p = 0.76	24	32.00 ± 5.46	t = 3.622 p = 0.001* df = 38
	CG	17	26.00 ± 3.42		16	26.31 ± 3.75	
Semi-professional	IG	100	27.65 ± 4.35	t = -1.351 df = 18, p = 0.19	94	34.28 ± 5.46	t = 9.637 p = 0.001* df = 185
	CG	108	26.66 ± 3.96		93	27.88 ± 3.35	
SES Class II	IG	61	27.31 ± 5.14	t = 1.078 p = 0.28 df = 111	60	33.82 ± 5.46	t = 6.283 p = 0.001* df = 103
	CG	52	26.36 ± 3.98		45	27.89 ± 3.68	
SES Class III	IG	53	27.03 ± 3.46	t = 0.831 p = 0.40 df = 99	47	33.60 ± 5.83	t = 5.956 p = 0.001* df = 84
	CG	48	26.50 ± 2.98		39	27.44 ± 3.02	

Physical Activity Scores

Table 3 presents pre- and post-intervention physical activity (PA) scores. PA scores did not differ significantly between groups at baseline. Post-intervention, mean PA scores were significantly higher in the Intervention Group than in the Control Group.

Table 3: Pre- and post-intervention physical activity scores among Intervention and Control groups

Group	Pre-intervention			Post-intervention		
	N	Mean PA score (SD)	t (df), p	N	Mean PA score (SD)	t (df), p
IG	145	227.76 ± 102.99	t = -1.884 p = 0.061 df = 288	137	329.56 ± 116.64	t = 4.026 p = 0.001* df = 259
CG	145	250 ± 98	--	124	275.60 ± 97.86	--

Table 4 stratifies PA scores by age, education, occupation, and socio-economic status. Scores were comparable between groups at baseline across all sub-groups. Post-intervention, participants in the Intervention Group aged 31–60 years, those with high-school education, skilled workers, and those in SES Class II and III showed statistically significant improvement compared with their pre-intervention scores.

Table 4: Pre- and post-intervention physical activity scores stratified by age, education, occupation, and socio-economic status

Sub-group	Group	Pre-intervention			Post-intervention		
		N	Mean (SD)	t (df), p	N	Mean (SD)	t (df), p
Age 31-60 yrs	IG	64	230.08 ± 105.6	t = -0.989 p = 0.32 df = 133	59	330.93 ± 121.26	t = 2.932 p = 0.004* df = 115
	CG	71	247.54 ± 99.47		58	271.55 ± 96.13	
High school	IG	112	228.35 ± 84.59	t = -1.613	112	331.03 ± 105.86	t = 5.261

				df = 207, p = 0.10			p = 0.001* df = 197
	CG	97	248.71 ± 97.91		87	258.91 ± 81.32	
Skilled	IG	100	221.50 ± 87.97	t = -2.45 p = 0.01* df = 206	94	329.79 ± 114.43	t = 4.246 p = 0.001* df = 185
	CG	108	253.94 ± 101.84		93	264.78 ± 93.77	
SES Class II	IG	61	217.21 ± 87.14	t = -1.661 p = 0.09 df = 111	60	312.50 ± 110.22	t = 2.237 p = 0.02* df = 103
	CG	52	244.23 ± 84.97		45	267.22 ± 91.51	
SES Class III	IG	53	220.75 ± 104.09	t = -1.489 p = 0.14 df = 99	47	326.60 ± 111.85	t = 3.236 p = 0.002* df = 84
	CG	48	252.08 ± 107.16		39	257.69 ± 78.88	

Within-group Change (Intervention Group)

Table 5: Dietary and physical activity scores within the Intervention Group, pre- and post-intervention

Variable	Timing	N	Mean (SD)	t (df), p
Dietary score	Pre-intervention	124	27.75 ± 5.33	p = 0.001*
	Post-intervention	124	28.49 ± 4.38	
Physical activity score	Pre-intervention	124	248.99 ± 94.58	p = 0.001*
	Post-intervention	124	275.60 ± 97.86	

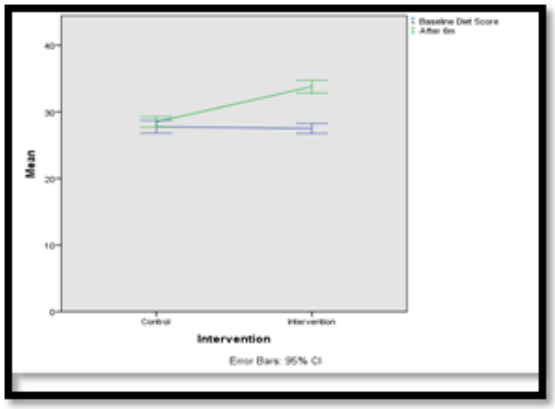

Figure 1: Error-bar plot showing the significant improvement in dietary scores of the Intervention Group after 6 months

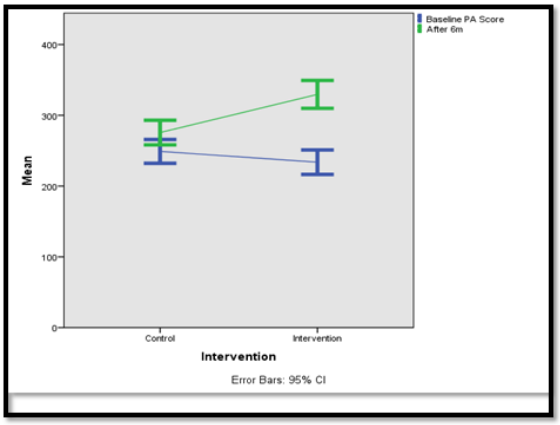

Figure 2: Physical activity of participants in the Control and Intervention groups before and after 6 months, showing significantly greater improvement in the Intervention Group

DISCUSSION

At baseline, participants in the IG and CG had comparable dietary and physical activity scores. Dietary scores in both groups were categorised as "moderately healthy," and physical activity scores were below 250 METs in both groups. Mean diet scores at baseline were 27.46 ± 4.39 (IG) and 27.53 ± 5.05 (CG) — essentially identical. Following the mHealth intervention, mean diet scores rose to 33.80 ± 5.68 (IG) and 28.49 ± 4.38 (CG); although both groups improved significantly, scores remained in the "moderately healthy" range. Mean PA scores at baseline were 227.76 ± 102.99 (IG) and 250 ± 98 (CG), both below 250 METs; after six months these rose to 329.56 ± 116.64 (IG) and 275.60 ± 97.86 (CG), with the IG surpassing the 250-MET threshold.

Reception of the mHealth intervention did not differ significantly across age groups, with both diet and physical activity scores improving in both younger and older participants. This is somewhat unexpected given that age is often reported to influence mHealth adoption. A meta-analysis of 35 studies by Zhao, Ni, and Zhou on factors influencing mobile-health adoption found that user-friendly mHealth design, perceived vulnerability, and perceived severity were important facilitators of adoption among middle-aged and older users.[14]

Participants were categorised by occupation as semi-professional, skilled, semi-skilled, or unskilled. There was no significant difference in baseline diet or PA scores across occupational categories. Post-intervention, mean diet scores improved significantly among semi-skilled and skilled workers, plausibly because higher-paying roles afforded better access to nutritious food. PA scores also improved significantly among skilled workers; improvement among semi-professional workers was present but not statistically significant, as this group already had comparatively favourable scores at baseline that persisted post-intervention.

Telephone conversations suggested that participants in higher-paying occupations experienced less physical fatigue at work, allowing greater engagement in recreational physical activity, which

was reflected in improved PA scores. Conversely, participants working as gardeners or helpers reported that their physically demanding jobs left them feeling they did not need additional recreational activity. Dropouts were concentrated among unskilled workers, suggesting that occupational background influenced engagement with the mHealth intervention. This is broadly consistent with a qualitative study by Khatu Fatema, Heywood, and colleagues on community readiness for mHealth adoption in rural Bangladesh, based on 37 in-depth interviews across four readiness domains (core, technological, human-resource, and motivational readiness), which found that community leaders and healthcare providers were more receptive to mHealth than farmers, drivers, or homemakers.

Participants' education was categorised as illiterate, pre-high-school, high-school, or post-high-school (including those who had completed SSLC, PUC, or a post-high-school diploma/degree). Baseline diet scores across educational categories fell in the moderately healthy range (22–33), except for participants with post-high-school education, whose scores were already higher at baseline. Post-intervention, diet scores improved significantly among participants with high-school and post-high-school education, suggesting a greater capacity to understand the importance of a healthy diet in preventing NCDs.

Participants with post-high-school education in the Intervention Group achieved PA scores of roughly 450 METs per week — consistent with about 20 minutes of moderate activity on three days per week. PA scores also improved significantly among those with high-school education in both groups (331.03 ± 105.86 in IG versus 258.91 ± 81.32 in CG). Telephone counselling suggested that better-educated participants more readily grasped the long-term benefits of physical activity for NCD prevention, which facilitated behaviour change. This is broadly consistent with a randomized controlled trial by Müssener and colleagues assessing mHealth for smoking cessation among 535 high-school students, in which three-month prolonged abstinence was reported by 23.1% of the intervention group (monthly text messaging) versus 19.4% of controls, attributed in part to participants' capacity to engage with the intervention content.[15]

Baseline diet scores were comparable across SES categories. Post-intervention, diet scores improved significantly in SES Classes II, III, and IV, but not Class I, whose participants already had better diet scores at baseline, likely reflecting greater capacity to afford healthy food. At baseline, PA scores in SES Classes I–III were below 250 METs, while Class IV (245.83 ± 101.26 in IG; 263.97 ± 98.31 in CG) exceeded this threshold — an inverse relationship between SES and baseline physical activity, likely reflecting more physically demanding occupations among lower-SES participants. Post-intervention, PA scores improved significantly in Classes I, II, and III, suggesting that SES influenced the degree of improvement achievable through the intervention. Participants in Class IV were largely unskilled workers in physically strenuous jobs, who may not have perceived a need for additional recreational activity; conversely, higher-SES participants could more readily afford facilities such as suitable footwear, supporting adoption of physical activity as a lifestyle habit.

CONCLUSION

Telephonic mHealth counselling played a significant role in improving dietary habits and physical activity among Intervention Group participants. Mean diet scores improved significantly across age groups following the intervention. Participants in SES Class I had better diet scores even before the intervention, while those in Classes II, III, and IV showed post-intervention improvement. Participants with high-school and post-high-school education, and those employed as semi-skilled or skilled workers, showed the greatest improvement in diet scores. Mean physical activity scores improved significantly in both age categories, with no evident age-related difference. Participants with high-school education showed greater improvement in physical activity, plausibly reflecting better understanding of its long-term benefits, while skilled workers showed the greatest improvement among occupational groups. Participants in SES Classes I, II, and III had greater improvement in physical activity scores relative to Class IV.

Strengths and Limitations

Strengths

This was a randomized controlled trial with 290 female participants spanning a wide age range (18–60 years) and diverse educational, occupational, and socio-economic backgrounds. The mHealth intervention was delivered via telephonic counselling and did not require a smartphone, making it accessible to participants with basic handsets, including those unable to read or write. The study retained 90% of participants through the full intervention period, with each monthly call lasting approximately 6–7 minutes and providing an opportunity for participants to raise queries about diet and physical activity.

Limitations

The study was limited to women from a single garment factory, and blinding was not feasible given the nature of the intervention. Outcomes were assessed via self-reported, questionnaire-based behavioural measures, and dietary scores did not capture micro- or macro-nutrient intake in detail. Some dropout occurred among participants unable to commit the time for phone calls. A Hawthorne effect cannot be ruled out, as participants were not blinded and may have responded more favourably to questions given repeated telephonic contact.

Declarations

Acknowledgement: Nil.

Trial Registration: Clinical Trials Registry of India (CTRI) — REF/2021/01/040313.

Ethical Clearance: Institutional Ethics Committee approval for study commencement was obtained on 24/12/2020 (SDUMC/KLR/IEC/576/2020-21); approval for publication was obtained on 01/03/2021 (SDUMC/KLR/IEC/729/2022-23).

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