Impact of a financial incentive scheme on purchase of fruits and vegetables from unorganised retailers in rural India: a cluster-randomised controlled trial

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Summary

Background Inadequate intake of fruits and vegetables is prevalent in rural areas of India, where around 65% of the population reside. Financial incentives have been shown to increase the purchase of fruits and vegetables in urban supermarkets, but their feasibility and effectiveness with unorganised retailers in rural India is unclear.

Methods A cluster-randomised controlled trial of a financial incentive scheme involving ~20% cashback on purchase of fruits and vegetables from local retailers was conducted in six villages (3535 households). All households in three intervention villages were invited to participate in the scheme which ran for three months (February–April 2021), while no intervention was offered in control villages. Self-reported (pre-intervention and post-intervention) data on purchase of fruits and vegetables were collected from a random sub-sample of households in control and intervention villages.

Findings A total of 1109 households (88% of those invited) provided data. After the intervention, the weekly quantity of self-reported fruits and vegetables purchased were (i) 18.6 kg (intervention) and 14.2 kg (control), baseline-adjusted mean difference 4 kg (95% CI: –6.4 to 14.4) from any retailer (primary outcome); and (ii) 13.1 kg (intervention) and 7.1 kg (control), baseline-adjusted mean difference 7.4 kg (95% CI: 3.8–10.9) from local retailers participating in the scheme (secondary outcome). There was no evidence of differential effects of the intervention by household food security or by socioeconomic position, and no unintended adverse consequences were noted.

Interpretation Financial incentive schemes are feasible in unorganised food retail environments. Effectiveness in improving diet quality of the household likely hinges on the percentage of retailers willing to participate in such a scheme.

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Keywords: Financial incentives; Food purchasing behaviours; Fruit and vegetable intake; Chronic disease prevention; India; Cluster randomised trial

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Research in context

Evidence before this study

We searched PubMed, Web of Science and EconLit for papers in any language published from Jan 1, 1990, to Dec 31, 2020. The search terms used were "financial incentive or reward" and "fruits or vegetables" and restricted to "randomised controlled trial or systematic review". We reviewed the 68 returned abstracts to identify 18 relevant articles, mostly based on same few interventions in US cities. The risk of bias for many studies was moderate (many well-conducted studies but based on a before-after, rather than randomised controlled, design). While the studies consistently showed the effectiveness of financial incentives in increasing the purchase of fruits and vegetables from organised retailers (i.e., supermarkets or large grocers), we found no studies in the context of unorganised retailers (e.g., street vendors) typically seen in rural areas of low-income and middle-income countries.

Added value of this study

To our knowledge, this is the first randomised controlled trial of a financial incentive scheme aimed at increasing the purchase of fruits and vegetables from unaffiliated retailers in a rural area of a low-income or middle-income country. The results confirm the feasibility of using such interventions in unorganised food retail environments and suggest that such interventions may be effective, although the study was not large enough to yield definitive results.

Implications of all the available evidence

The evidence on feasibility of the intervention and promising (although not confirmatory) results seen in this study, taken together with previous evidence from other contexts and the limited risks associated with such an intervention, encourages policy makers to consider use of financial incentives in promoting healthier food choices.

Introduction

Low intake of fruits and vegetables is amongst the leading causes of death and disability globally.[1] It increases the risk of cardiovascular disease, diabetes, cancer, poor bone health, impaired vision, mental health disorders, and micronutrient deficiencies.[2] From a planetary perspective, lower intake of fruits and vegetables relative to animal-based foods is associated with increased greenhouse gas emission, accelerated soil and ecosystem damage, and greatly increased water usage, among other challenges.

Intake of fruits and vegetables in India is amongst the lowest in the world, with three-fourths of the population estimated to consume less than the WHO recommendation of 400 g daily.[3] The intake of fruits and vegetables in rural India (total rural population ~900 million) is even lower than in urban India.[3,4] With increasing urbanisation and globalisation, communities in rural India will undoubtedly be exposed further to environmental risk factors of non-communicable diseases. The establishment of healthy dietary patterns, including sufficient intake of fruits and vegetables, at an early stage of epidemiological transition may help to stem the unfolding epidemic of non-communicable diseases in rural India, as well as limiting the environmental impacts of these changes.[5,6]

Attempts to increase the intake of fruits and vegetables through nutrition education programs have met with limited success globally. Whilst improving knowledge is important, people's food choices are influenced more strongly by the environments in which these choices are made; as a result, there is a strong interest in evaluating interventions that target food environments. Among these, a range of grocery store interventions, including product labelling and positioning, promotions, subsidies, and notably financial incentives (as cash or vouchers that can be exchanged for desirable items), have been evaluated.[7] However, these studies were invariably conducted in supermarkets (or large grocers) of high-income countries (or urban areas of some middle-income countries).[7–9] Furthermore, many of these studies are observational or pre-post intervention studies, and we are not aware of any randomised evaluations of financial incentives for fruit and vegetable intake outside of the United States (apart from one trial in France).[10–13] There is little evidence on the effects of incentives and incentive types (e.g., level, type, or modality) on grocery shopping behaviours in rural areas of low-income and middle-income countries (LMICs), where most groceries are purchased from a variety of unorganised retailers such as street vendors, leaving policy makers with little basis for designing effective interventions.[14]

To address this research gap, we developed a financial incentive scheme in partnership with a rural community in India and evaluated its effectiveness. Our primary hypothesis was that the financial incentive scheme would result in an overall increase in the total quantity of fruits and vegetables purchased by households. Our secondary hypotheses were that the increase would be (a) relatively greater for purchases made from local retailers participating in the incentive scheme, and (b) similar across socio-economic and food security status groups.

Methods

We developed and iteratively refined the intervention using a systematic process and evaluated it using a cluster-randomised controlled trial.

Study setting

The study was conducted at the site of an established cohort study (the Andhra Pradesh Children and Parents' Study, APCAPS) which includes all households of 29 villages located in Ranga Reddy district of Telangana state, India.[15] The villages are situated 25–50 km from Hyderabad city, in a geographically contiguous area which is relatively homogenous in respect to culture, predominant occupations, cuisine/dietary habits and food availability and acquisition. The households (N = 24,819) were last surveyed in 2014 and their contact information was updated. The present intervention was developed in 24 APCAPS villages and evaluated in six of those villages. Ethical approvals were obtained from the Indian School of Business, Hyderabad, India; Indian Council of Medical Research-National Institute of Nutrition, Hyderabad, India; and the London School of Hygiene & Tropical Medicine (LSHTM), London, UK.

Intervention development

We developed the financial incentive intervention using the stages outlined in Medical Research Council —National Institute for Health and Care Research (MRC/NIHR) guidance on development of complex interventions, following principles of the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework to maximise potential impact of the intervention.[16,17] The intervention development process was also guided by Turner's conceptual framework of the food environment.[18] First, we conducted a participatory workshop with 22 stakeholders (drawn from local leadership, community members, food retailers, relevant policy makers and industry representatives) to discuss preliminary ideas and develop a roadmap for intervention development. Second, we conducted a scoping literature review to identify financial incentive schemes used in grocery shopping environments. Third, we collected data using quantitative and qualitative methods to characterise the local fruits and vegetables purchasing environment, which included mapping of the fruit and vegetable supply chain (including sources and business models at each stage) and documenting the consumer attitudes, practices and financial considerations related to the purchase of fruits and vegetables. The data collection was carried out in 24 least-urbanised APCAPS study villages (based on population size from last census). The methods of data collection have been published in detail elsewhere, but briefly they included a quantitative survey of 308 households, in-depth interviews with 34 fruit and vegetable retailers and 24 key informants, and nine focus group discussions involving 94 community members.[19] Fourth, findings from the above steps were used to support identification of five potentially feasible incentive schemes (fixed discount scheme, points system, a tiered loyalty scheme, prepaid program, and cashback loyalty program). Fifth, we presented these five potential schemes to a sub-group of eight retailers (to elicit their preferences and potential challenges to their delivery and misuse) to identify the most preferred and feasible scheme. Sixth, we developed the prototype delivery material for the scheme (e.g., coupon booklets, stamps, information leaflets) and iteratively refined it with 50 participants over two rounds to establish the preliminary mode of scheme delivery, threshold (median household expenditure on fruits and vegetables) and reward values (20% of expenditure). Finally, a pilot study was implemented in two study villages to test the intervention, and feedback used to make further changes (such as reducing the value of stamps to account for smaller purchases) before finalising the scheme, which was evaluated in the trial described below.

Intervention evaluation

The intervention was evaluated through a cluster randomised controlled trial. The trial protocol was preregistered on the American Economic Association Randomised Controlled Trial Registry (RCT ID: AEARCTR-0004939). The present evaluation is reported in accordance with the CONSORT guidelines and extensions for cluster randomised trials (see Supplementary Material).

Study design and participants

The trial was conducted in six APCAPS villages.[15] To ensure that the trial villages were comparable for characteristics relevant to the trial, only villages within the inter-quartile range of 24 APCAPS villages for the following characteristics were considered for inclusion: population size, number of fruit and vegetable retailers, and proportion of population who purchase fruits and vegetables within the village. The population size data was available from the last census of APCAPS villages in 2014, and data on retailers and sources of purchase for fruits and vegetables were collected as part of the aforementioned surveys conducted as part of the intervention development process. This restriction resulted in eight non-adjacent villages from which we sought consent for participation through their village leaders, before randomly allocating six villages (in 1:1 ratio using computer generated random number list) to the intervention or control arm and used the remaining two villages for the pilot study before the trial. Individual-level consent was subsequently sought from all community members and retailers who contributed data to the study.

Description of the intervention

The financial incentive scheme consisted of a coupon system that could be used to claim a cashback reward of 50 Indian Rupees (INR 50, equivalent to ~0.67 US$ at

the time of implementation), on weekly purchase of INR 250 (~3.36 US$) of fruits and vegetables from local retailers. To contextualise these amounts, most households in the study area earn between INR 5000–15,000 per month, meaning the reward corresponds to between 1.5 and 4% of weekly household income, and fruit and vegetable purchase threshold corresponds to 7–20% of weekly household income. All households in the intervention villages were invited to take part in the scheme and provided with a booklet containing enough coupons to last for the duration of the study. Each coupon had space for 25 stamps, each of value INR 10 (~0.13 US$) (Fig. 1). After completing any purchase of fruits and vegetables from the local vendors worth at least INR 10, participants could get one or more stamps (depending on the amount purchased in multiples of INR 10) on their coupon from the study staff stationed at the village markets during operating hours after showing their purchases (most produce in the area is sold in standard size bundles of similar weight). At the end of the week, participants could submit their completed coupon with 25 stamps and claim the cash reward. Each coupon was dated and valid only for that week to prevent accumulation of stamps over a prolonged period. The intervention ran for three complete calendar months (February–April 2021).

Outcome assessments

To assess the quantity of fruits and vegetables purchased before and after the intervention, a sub-sample of village households were randomly selected from the household census. If a selected household could not be contacted (over a maximum of two attempts on separate days) or declined to participate, additional households were randomly selected until the target number of households for each village was reached. The individual mainly responsible for food shopping in the household was asked to provide written consent and complete a brief baseline sociodemographic survey followed by two rounds of telephonic surveys (~4 weeks before the start and after the end of the intervention) about their fruit and vegetable purchases. During the telephonic surveys, to ensure accurate recall, participants were called on alternate days (4 times over a 7-day period) to collect data on any fruits or vegetables purchased or otherwise obtained (quantity in relevant units, amount spent in INR, and source for each item) since the last call. The data collection in intervention and control villages was carried out in parallel to limit any bias arising from seasonal variability in grocery purchasing habits, which was also accounted for in the analysis (see below).

The pre-specified primary outcome for this analysis was the total quantity in kilograms (kg) of fruits and vegetables purchased by households in a week from any retailer. The reported quantity of individual fruit and vegetable items purchased every other day over the seven-day period were summed to estimate the weekly total. For produce not typically purchased by weight (such as bunches of herbs and leafy vegetables and pieces of large individual fruits and vegetables), sample items were obtained from markets in the trial villages and weighed, with the average weights applied to the relevant items.

The key secondary outcomes were the quantity of fruits and vegetables (kg) purchased (i) from local retailers (since a certain proportion of groceries were purchased from retailers outside the study villages who were not part of the incentive scheme); and (ii) by socio-economic and food security status groups (since public health interventions could exacerbate disparities if disproportionately uptaken by higher socio-economic groups). Food security was measured at baseline using the nine-item Household Food Insecurity Access Scale (HFAIS), and each household was scored as recommended by the developers of the scale (none, mild, moderate, or severe food insecurity) before being analysed as two groups (none versus the rest).[20] Socioeconomic status was measured at baseline using a modified version of the Standard of Living Index, a household asset index commonly used in India.[21] We asked respondents whether their household owned each of 14 items, and the responses were combined using

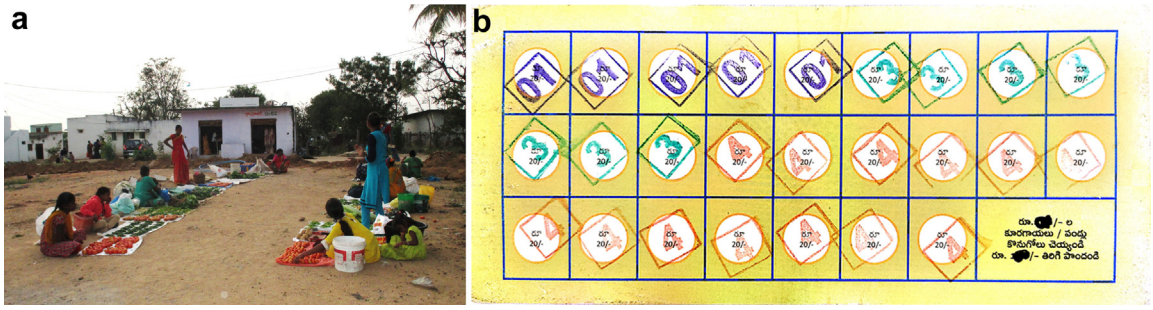


Fig. 1: Photographs to illustrate: a) Fruit and vegetable selling at the trial site, and b) Coupon vouchers used for the intervention (different numbered stamps were used to demark the different days in which purchases were made).

principal component analysis to give a standardised score (higher score indicating greater socioeconomic status), which was split into two groups (above or below the median score).

We also examined the effect of intervention (i) separately for fruits and vegetables (to identify any differential effects); (ii) excluding onions (because of strong price fluctuation in this item); (iii) excluding starchy vegetables (considered in some classifications as a carbohydrate source rather than vegetable); and (iv) on quantity of fruits and vegetables obtained from all sources (i.e., including own cultivation, wild harvest, etc.). All outcomes were examined in monetary terms (i.e., amount spent on fruit and vegetables in INR) in addition to the amount purchased in weight.

Statistical analyses and study power

We assessed the difference in purchases of fruits and vegetables at the end of intervention between intervention and control villages using multilevel linear regression. Under the intention-to-treat principle, data from all households participating in the survey were analysed, regardless of their actual participation in the intervention. Outcomes were treated as continuous without transformation following visual inspection of diagnostic plots. Data were structured at the household level. We used a random intercept term at the village level to account for clustering within villages and Kenward-Roger correction to account for the small number of clusters.[22] The main effects were estimated from models adjusting for quantity of fruits and vegetables purchased by the households at baseline, village-level mean fruits and vegetables purchase (to improve precision),[23] and the month of the baseline and end-line surveys (to account for seasonal variations in availability and prices of fruits and vegetables). Another model adjusted for additional covariates that could potentially confound the observed effect estimates. These included household size, proportion of household members who are <18 years of age, household dependency ratio, household asset score, whether village market was the household's primary source of fruit and vegetables, and weekly quantity of fruits and vegetables obtained from other sources by the household. Differences in the intervention effect by key sub-groups (food security status, household socioeconomic status) were examined by tests for statistical interaction. All statistical tests reported are two-sided and p-values are from Wald test unless stated otherwise. As loss-to-follow up was far less than our prespecified threshold (20%) for use of attrition weights, only complete case analysis was carried out.

The target sample size for this trial was 1200 households (~1500 before allowing for loss to follow-up), from 6 villages (the upper limit of villages we could include due to practical/financial constraints), which was estimated to provide 80% power (at 5% significance level) to detect a 15% difference (~1.73 kg) in primary outcome (weekly quantity (kg) of fruits and vegetables purchased at end-line), assuming a village-level intra-cluster correlation coefficient of 0.02 and mean household purchase of 11.5 kg (standard deviation 4.8 kg) of fruits and vegetables per week in the control arm, estimated from the pilot data.

Modifications to the protocol

We initially planned to conduct the trial from November 2019 to August 2020, with intervention delivery between January 2020 and June 2020. The intervention was to be delivered for 6 months, with surveys conducted pre-intervention and then every 2 months (at 2, 4 and 6 months). We conducted the pre-intervention (baseline) survey along with the pilot from November 2019 and were preparing to start the intervention when from February/March 2020 all fieldwork was severely disrupted by national, regional, and institutional COVID-19 restrictions. We were only able to restart in-person data collection in November 2020. This meant we had to re-do the baseline survey and modify the study protocol as we only had time and resources to deliver the intervention for 3 months, with a single survey post-intervention. The target sample size was not changed, but with only 1 post-intervention measure per-household, the power calculation had to be altered as we would only be able to detect a ~15% difference (rather than original planned 10% difference). Based on further analysis of the process data from the pilot, during this time we also modified the planned intervention such that the value of the coupons and value of purchases required to redeem them were halved (based on participant feedback and observation of lower fruit and vegetable purchase than expected). All changes were made prospectively, and analyses were conducted in an anonymised fashion following the prespecified analysis plan.

Role of the funding source

The study sponsor had no role in study design; collection, analysis, and interpretation of data; in writing of the report; or in the decision to submit the paper for publication.

Results

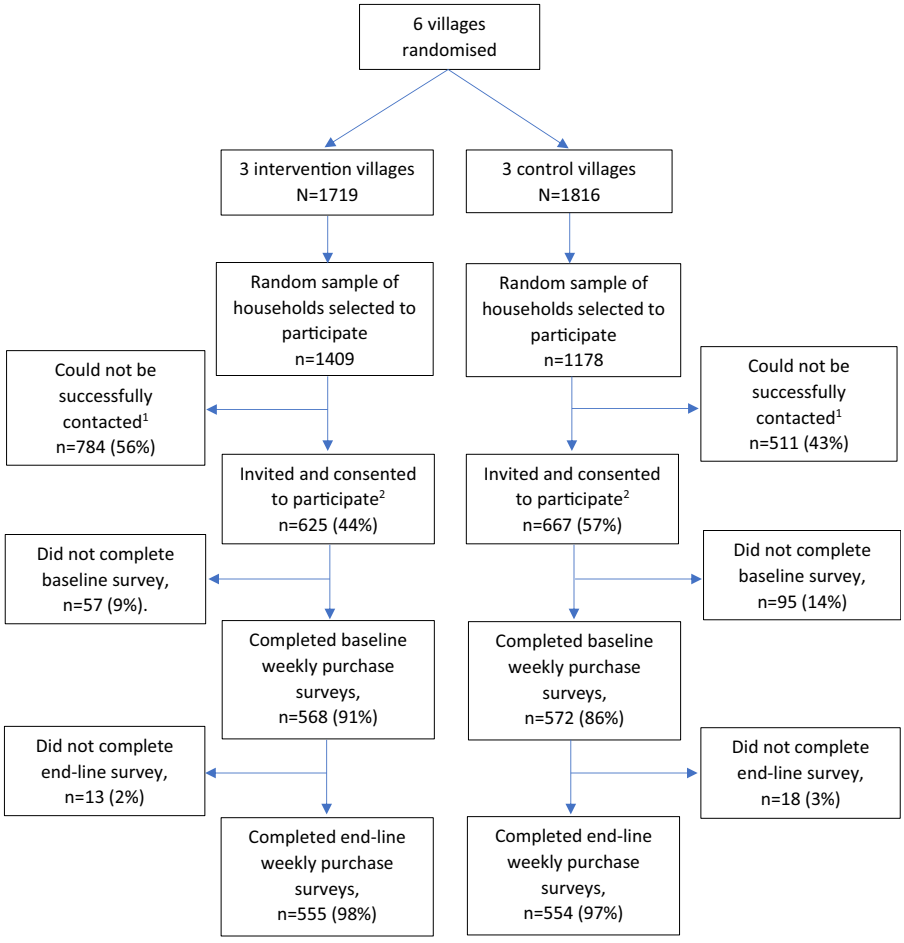
A total of six villages (total households 3535; population 15,191) were randomised (Fig. 2). All households in the intervention villages were invited to take part in the incentive scheme. A random sample of 2587 households in all villages were invited to take part in the surveys, of which approximately half could be contacted during the maximum of two contact attempts. All of those contacted agreed to take part and gave informed consent (N = 1292). After excluding those households who did not complete either the baseline (11.8%) or end-line

(2.4%) surveys, complete data on 555 (89%) intervention and 554 (83%) control households were available for analyses. The proportion who did not complete endline surveys (i.e., lost-to-follow-up) was similar between trial arms (2.1% intervention vs 2.7% control, p = 0.47), and there was no evidence of difference between completers and non-completers (Appendix Table S1).

The socioeconomic characteristics of the participating households were typical of many rural populations in India (Table 1).[21] Less than half of the households had highest education level as higher than secondary school, and 12% of the households reported moderate or severe food insecurity. Around 25% of the households reported producing fruits and vegetables for selling or their own consumption. The mean quantity of fruits and vegetables purchased by households was 13 kg per week.

Intervention and control villages were similar in terms of study population (intervention mean: 2368, control mean: 2407), distance from the city of Hyderabad (intervention mean: 53 km, control mean: 40 km), and number of fruit and vegetable vendors present (intervention mean: 21, control mean: 24). The baseline characteristics of participating households from the intervention and control villages were also similar although we did note a higher average quantity of fruits and vegetables purchased per week by households in the intervention villages (13.7 kg) as opposed to the control villages (11.3 kg), and a lower proportion reporting food insecurity in intervention villages (19.1%) compared with control villages (28.7%).

The post-intervention survey was carried out 2–6 weeks after the end of the intervention. Following the intervention, the intervention villages purchased 18.6 kg of fruits and vegetables per week as compared to 14.2 kg in the control villages, equating to a baseline adjusted mean difference of 4 kg (95% CI: −6.4 to +14.4) (Table 2, and outcomes by village given in Appendix Table S2). When considering only purchases of fruits and vegetables from local vendors (i.e., those eligible for



[1]After at least 2 household visits by the field staff on different days.
[2]All of the households successfully contacted were invited to the study and consented to participate.

Fig. 2: Flow chart of included participants.

Characteristic	Mean (SD) (unless otherwise stated)		
	Control N = 554	Intervention N = 555	Total N = 1109
Number of household members	4.4 (1.6)	4.6 (1.7)	4.5 (1.7)
Proportion of household members <18 years old	0.27 (0.22)	0.27 (0.22)	0.27 (0.22)
Household dependency ratio (ratio total n members: n economically active members)	2.8 (1.9)	2.9 (2.1)	2.9 (2.0)
Highest education level in household, n (%)			
None	44 (7.9%)	56 (10.1%)	100 (9.0%)
Primary/secondary	320 (57.8%)	286 (51.5%)	606 (54.6%)
Higher	190 (34.3%)	213 (38.4%)	403 (36.3%)
Household food insecurity, n (%)			
Not insecure	395 (71.3%)	449 (80.9%)	844 (76.1%)
Mild	75 (13.5%)	55 (9.9%)	130 (11.7%)
Moderate	79 (14.3%)	40 (7.2%)	119 (10.7%)
Severe	5 (0.9%)	11 (2.0%)	16 (1.4%)
Household asset score[a]	0.0 (1.6)	−0.0 (1.7)	−0.0 (1.6)
Household produces FV for selling, n (%)	61 (11.0%)	72 (13.0%)	133 (12.0%)
Household produces FV for own consumption, n (%)	108 (19.5%)	149 (26.9%)	257 (23.2%)
Quantity FV (kg) purchased per household per week from retailer anywhere	11.3 (6.2)	13.7 (6.4)	13.0 (6.6)
Quantity FV (kg) purchased per household per week from local retailers only	5.6 (3.5)	7.4 (4.7)	6.5 (4.2)
Quantity of FV (kg) obtained from other sources (e.g., grown, foraged) per household per week	0.11 (0.49)	0.57 (2.07)	0.34 (1.52)
Total quantity of FV (kg) obtained from all sources (i.e., purchased or grown/foraged) per household per week	11.8 (6.3)	14.8 (6.7)	13.3 (6.7)

[a]Derived from principal component analysis of common household assets (mean 0, higher score indicates higher wealth).

Table 1: **Baseline characteristics of participating households (n = 1109), APCAPs Fruit and Vegetable Incentive Trial 2020–2021.**

participation in the intervention), households in the intervention villages purchased 13.1 kg of fruits and vegetables per week, as compared to 7.1 kg in the control villages, equating to a baseline-adjusted mean difference of 5.9 kg (95% CI: 2.6–9.1). The baseline-adjusted mean differences were similar among food insecure and food secure households, and among households above or below median socioeconomic status (Table 3, and similar when analysing only local retailers given in Appendix Table S3). No other unintended adverse consequences

	Intervention mean (SD)	Control mean (SD)	Unadjusted model		Baseline adjusted[a]		Covariate adjusted[b]	
			Beta (95% CI)	P-value	Beta (95% CI)	P-value	Beta (95% CI)	P-value
Quantity in kilograms (per household per week)								
FV purchased from any retailer[a]	18.6 (7.6)	14.2 (6.3)	4.19 (−1.25, 9.64)	0.099	3.98 (−6.42, 14.38)	0.31	4.18 (−6.51, 14.87)	0.30
FV purchased from local retailers[b]	13.1 (7.0)	7.1 (4.0)	5.85 (2.64, 9.06)	0.007	7.39 (3.84, 10.94)	0.007	7.46 (3.91, 11.02)	0.007
FV obtained from all sources[c]	18.8 (7.6)	14.4 (6.3)	4.20 (−2.29, 9.68)	0.10	4.61 (−6.63, 15.85)	0.28	4.84 (−6.65, 16.34)	0.27
Fruit only	4.1 (3.5)	3.3 (3.0)	0.78 (−0.48, 2.05)	0.16	0.56 (−0.58, 1.70)	0.21	0.54 (−0.69, 1.77)	0.25
Vegetables only	14.5 (6.1)	10.9 (4.6)	3.40 (−1.59, 8.39)	0.13	2.81 (−6.69, 12.31)	0.42	2.78 (−6.87, 12.44)	0.43
FV excluding onions	16.4 (6.7)	12.6 (5.5)	3.49 (−0.91, 7.88)	0.091	4.27 (−3.96, 12.49)	0.20	4.31 (−4.23, 12.89)	0.21
FV excluding starchy vegetables	17.5 (7.2)	13.3 (5.9)	4.02 (−1.01, 9.04)	0.090	3.73 (−5.94, 13.40)	0.31	3.79 (−6.18, 13.82)	0.31

FV = fruits and vegetables. Results are based on multilevel linear regression models including a random intercept at village level to account for clustering in outcome, and Kenwood-Roger correction for small number of clusters. [a]Primary outcome, which is adjusted for baseline level of outcome (individual- and village-level) and month of baseline and end-line surveys. [b]Key secondary outcome, which is adjusted for baseline level of outcome (individual- and village-level), month of baseline and end-line surveys, household size, proportion of household <18 years, household dependency ratio, asset score, use of village market and whether household produces fruits or vegetables for consumption. [c]Includes FV purchased as well as cultivated, foraged, or received in-kind/as gifts.

Table 2: **Effect of incentive intervention on primary and secondary outcomes (control arm is reference category, n = 1109 households), APCAPs Fruit and Vegetable Incentive Trial 2020–2021.**

Outcome and subgroup	Unadjusted model		Baseline adjusted[a]		Covariate adjusted[b]	
	Beta (95% CI)	P–value interaction	Beta (95% CI)	P–value interaction	Beta (95% CI)	P–value interaction
Quantity of FV purchased in kilograms (per household per week)						
Food insecure	5.79 (1.38, 10.20)	0.061	4.81 (−1.81, 11.45)	0.36	4.89 (−1.98, 11.77)	0.38
Food secure	3.73 (−0.38, 7.84)		3.89 (−2.56, 10.34)		4.01 (−2.70, 10.73)	
Lower socioeconomic position	4.90 (0.99, 8.80)	0.11	4.35 (−2.07, 10.78)	0.41	4.57 (−2.10, 11.23)	0.28
Higher socioeconomic position	3.60 (−0.30, 7.51)		3.75 (−2.67, 10.17)		3.78 (−2.88, 10.44)	

FV = fruits and vegetables. Results are based on multilevel linear regression models including a random intercept at village level to account for clustering in outcome, and Kenwood-Roger correction for small number of clusters. [a]Adjusted for baseline level of outcome (individual- and village-level) and month of baseline and end-line surveys. [b]Adjusted for baseline level of outcome (individual- and village-level), month of baseline and end-line surveys, household size, proportion of household <18 years, household dependency ratio, use of village market and whether household produces fruits or vegetables for consumption.

Table 3: **Effect of incentive intervention on weekly fruit and vegetable purchase (kg) among food security and socio-economic position subgroups (control is the reference category, n = 1109 households), APCAPS Fruit and Vegetable Incentive Trial 2020–2021.**

were noted in the study. The results were broadly similar for fruits and vegetables analysed separately and on excluding onions or starchy vegetables (Table 2). They were also robust when analysed in monetary terms (i.e., amount in INR spent on of fruits and vegetables) rather than by weight (Appendix Tables S4 and S5).

Discussion

We conducted a cluster-randomised controlled trial of a financial incentive scheme offering a ∼20% cashback on purchase of fruits and vegetables from unorganised local retailers in rural India. The scheme ran for three months in three of the six trial villages. After the scheme was over, the weekly household purchase of fruits and vegetables was ∼28% higher for intervention villages compared to control villages (corresponding to ∼1.5 portions of fruit and vegetables per person per day). When considering purchases made at local retailers only (able to participate in the scheme), weekly household purchase was ∼104% higher in intervention villages than control villages. This could be partly explained by participants switching to purchase more fruit and vegetables from local participating retailers instead of non-local retailers, demonstrating a high level of engagement in the scheme, and highlighting that in unorganised food retail environments, it may be important for incentive schemes to be broad-based (i.e., consolidating multiple vendors) in order to maximise their impact. In this setting, around half of fruit and vegetables purchased were from local vendors participating in the scheme. It is likely that the greater effects would have been noted had vendors from neighbouring villages been included in the intervention (not possible in this trial context due to potential spill over/contamination effects).

Unlike the increase in purchases from participating local retailers, the increase in purchases from retailers anywhere was not statistically robust with wide confidence intervals suggesting that our study may have been underpowered for the primary outcome. While the in-trial central effect estimate of 28% exceeded our anticipated effect size of 15% from previous literature, the in-trial standard deviation (6.2 kg) and village-level intraclass correlation coefficient (0.15) of the primary outcome was greater than that obtained from the pilot study (4.8 kg and 0.02, respectively), possibly due to seasonal variability in grocery shopping patterns and smaller number of clusters in the trial (the pilot was conducted in a different season across 24 villages). Despite the lack of statistical significance of the primary outcome by conventional metrics,[24] the consistency of the direction and magnitude of the central effect estimate with research conducted in urban centres of high-income countries (showing increases equivalent to reward/discount amount) provides reassurance that financial incentive schemes may be a viable instrument for increasing the purchasing fruits and vegetables even in food environments of rural areas of LMICs dominated by unorganised retailers.[7,9] A lack of difference in the effect size across food security and socio-economic groups (which if anything was relatively greater in disadvantaged groups) provides further reassurance that such interventions (unlike many public health interventions) do not exacerbate disparities and are likely to benefit those who need them most. No other harms or unintended adverse consequences were noted in the study.

As far as we are aware there are no published evaluations of financial incentive schemes for unorganised retailers of fruits and vegetables.[14] Evaluations conducted in supermarket environments of high-income countries (and urban areas of some middle-income countries) have predominantly been based on before and after data (from checkout scanners) linked to programmatic introduction of incentive schemes,[7–9] with emerging evidence from randomised controlled trials mostly supporting their findings.[10,12] The majority of these studies suggest that financial incentives increase the purchasing of fruits and vegetables, although the magnitude of effect has been shown to vary substantially based on nature of behaviour, size of incentive,

population involved, social context and design, with effects varying by subtle changes in how incentives are situated, framed, or deployed.[25,26]

Several studies from the US have evaluated the benefits of incentives (e.g., bonus, rebate, or cash value vouchers) given to low-income families (as part of the Supplemental Nutrition Assistance Program) and found that levels of increases in purchase of fruits and vegetables are broadly proportionate to the reward value.[7] Likewise, in an evaluation of a scheme run by a health insurance plan across more than 400 supermarkets in South Africa, a 10% and 25% cash back reward for healthy food purchases resulted in 5.6% and 8.5% increase in the ratio of expenditure on fruits and vegetables to total food expenditure, respectively, after the introduction of the scheme.[9] On the other hand, the relatively modest impact (0.40 US$ increase in monthly expenditure on fruits and vegetables) of a financial incentive scheme implemented in an urban supermarket serving low-income families in the USA, despite a proportionately high reward value (a 10 US$ gift card offered for 10 US$ expenditure), was attributed to a high reward threshold (average expenditure on fruits and vegetables was 8.12 US$ per month), consistent with behavioural economics theory that the barrier in changing behaviour is much higher when the behaviour does not exist at baseline.[8,25] The likely magnitude of effect suggested by our data (~28% increase in purchase of fruits and vegetables associated with a reward equivalent to 20% of expenditure at a threshold equivalent to median expenditure) is broadly consistent, and potentially greater than previous research conducted predominantly with low-income families in the US, because the behaviour in question (i.e., purchase of fruits and vegetables) was widely prevalent at baseline.

There was limited research to compare our findings of an equitable impact of the intervention across food security and social groups. Most previous interventions evaluated interventions targeting low-income groups only.[7,8] Nevertheless, our findings have face validity as one would anticipate a greater perceived value of the reward for those of lower income.

This is one of the few randomised controlled trials of a financial incentive scheme aimed at influencing the purchase of fruits and vegetables, and the first (as far as we are aware) in the context of unorganised retailers who dominate the landscape of grocery shopping in rural areas of LMICs, including India. The intervention was informed by the state-of-the-art evidence from behavioural economics and developed through an extensive process of consultation with the local stakeholders and community to take account of the context and user preferences. The trial had a high response rate and limited loss to follow-up, reducing the potential for selection bias, and the data were analysed by the analyst unaware of the assignment of the trial arms.

There are also some limitations to note. The data on purchase of fruits and vegetables were self-reported. Collecting objective data through checkout scanners (as done in other studies) was not an option in this context. Our approach was also not validated as we could not identify an existing instrument suitable for this context, although its design mirrors most food recall questionnaires, and was based on extensive piloting at the study site. We made robust efforts to reduce inaccurate recall by telephoning the participants every other day (typical frequency of shopping from local vendors in this setting) of the data collection week to ensure that their memory was fresh. The participants were asked to report their specific purchases over the past 1–2 days (rather than total amount or intake), making it less prone to participants in the intervention arm providing socially desirable responses; still response bias cannot be ruled out entirely as the participants were aware of the intervention. It was also not feasible (due to respondent burden) to assess overall food consumption of the participants, which might have shed light on any compensatory changes in diet (e.g., reduced intake of pulses, meat) made in response to the intervention. Further, despite our best efforts to estimate the required sample size accurately by conducting a substantial pilot study, we were unfortunately underpowered for the primary study outcome. We believe that the higher variance of the primary outcome (possibly due to seasonal variability in purchasing patterns) and the higher village-level intraclass correlation coefficient (possibly due to lower number of village clusters) observed in the trial may have resulted in the lower statistical power. The limited number of trial villages (necessitated by the cost/practicality of providing intervention to all households in intervention villages) could also have resulted in unmeasured confounding by other differences between trial villages despite randomisation. Indeed, baseline data suggested differences in fruit and vegetable acquisition and consumption between intervention and control villages pre-intervention, and although these measured factors were adjusted for in our models, this implies the possibility of further differences in unmeasured factors that may have influenced the results. Statistical inference must also be more tentative when the number of clusters is small given that one cannot rely on large-sample approximations, although we did employ Kenwood-Roger small sample correction method to try to account for this. An alternative study design (offering incentives to a sub-set of households in more villages) which could have addressed this limitation was considered by investigators and local community to be more logistically and ethically challenging. Another potential limitation is that the trial was conducted in a finite geographical area, and we restricted the study to villages of around average size and fruit and vegetable retail availability for this area. Generalisation of these findings to other settings should be considered carefully in light of the food environment

and other contextual factors, such as the proportion of fruits and vegetables acquired locally, and proportion of food prepared at home (predominant in this setting) vs purchased as ready-to-eat. In addition, only around half of the households approached were able to be contacted to participate in the follow-up surveys (rest were locked/unavailable on days when the study team visited). This could potentially limit generalisability if those non-contactable households were different in key respects, although it is reassuring that the team tried to visit at all times of day (limiting systematic selection issues), and that all those we made contact with agreed to participate. Finally, the intervention period in this trial was three months, and post-intervention surveys were conducted 2–6 weeks after the intervention finished. It would have been of interest to understand the effects of longer-term implementation of the intervention, as well as whether any intervention effects were sustained beyond the study period.

The findings from this study suggest that policy makers in low-income and middle-income countries such as India could consider financial incentive schemes as a means of influencing food purchasing (and by extension dietary) behaviours even in rural areas where the food environment is dominated by a myriad of unorganised retailers. While financial incentives have been used by policy makers to influence health behaviours (such as smoking, diet, and physical activity), their use has also raised concerns.[27] Paying people for adopting healthy behaviours which is in their own interest is ethically controversial although common in low resourced areas.

Cost of financial incentive schemes is another concern, particularly for policy makers in low-resource settings.[28] Although the intervention is low cost by design, with for example the cashback rewards costing 1300 INR/~16 US$ per household for 6 months (likely to total comparatively less than other approaches such individual micronutrient supplementation programmes), it would be premature to comment on cost-effectiveness. Innovative implementation strategies, such as aligning the intervention with the supplier side incentives and demonstrating the economic value of such programs to the vendors (e.g., increased sales and customer loyalty), could achieve greater buy-in from the vendors and help sustain such interventions without any direct financial intervention from the government.

Since this was one of the first robust evaluations of a financial incentive scheme used to influence grocery shopping behaviours in rural areas of low-income and middle-income countries, more research is needed to confirm these findings in other geographical areas and extend them to other health behaviours, since findings are expected to vary with differences in populations, settings, behaviours, and incentives. Research over longer follow-up periods after the end of the intervention is needed to understand the long-term changes in behaviours and any adverse effects of such interventions, including changes in other health-related behaviours. Finally, research evaluating the scale-up of such interventions with self-sustaining business models is needed to ensure their long-term sustainability.

In conclusion, this research based on a cluster-randomised controlled trial has shown that financial incentive schemes are feasible in unorganised food retail environments, and despite uncertainty around effect estimate of primary outcome, may have a role in equitably increasing the purchase of fruits and vegetables.

Contributors

SK and EAF conceptualised the study. All authors contributed to the design of the study. JL prepared the protocol. SK, SD, SA, RP, and BK supervised the study. SB curated the data. PACM conducted the formal data analysis. SK and PACM wrote the first draft of the paper. SK and PACM have access to and have verified the data. SK and PACM contributed equally to the work. All authors edited the subsequent drafts and approved the final version of the paper for submission.

Data sharing statement

All deidentified participant data will be made available 18 months after study completion i.e., from July 01, 2023, to July 01, 2028. All data on research conducted in APCAPS cohort (including the present trial) is routinely made available on approval of a brief proposal submitted to the APCAPS cohort executive team through cohort website (https://apcaps.lshtm.ac.uk/), where data-related documentation (data dictionary etc) can also be found. Data is made available for all bona-fide research purposes without restrictions. Study-related documentation (protocol and questionnaires) are attached as appendices to this article.

Declaration of interests

SK receives research funding from Medical Research Council UK, University of Chiang Mai Thailand, and Ministry of AYUSH Gov of India. PM receives research funding from Medical Research Council UK and Ministry of AYUSH Gov of India. JL receives research funding from Medical Research Council, UK. HW receives research funding from Public Health England, the Health Services Research Initiative, and Helen Keller International, and has received honoraria from University of the Western Cape and ANH (Agriculture, Nutrition, & Health) Academy.

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Appendix ASupplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lansea.2022.100140.

References

1 Afshin A, Sur PJ, Fay KA, et al. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease study 2017. *Lancet*. 2019;393:1958–1972.

2 Wang X, Ouyang Y, Liu J, 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;349:g4490.
3 Hall JN, Moore S, Harper SB, Lynch JW. Global variability in fruit and vegetable consumption. *Am J Prev Med*. 2009;36:402–409.e5.
4 Sachdeva S, Sachdev TR, Sachdeva R. Increasing fruit and vegetable consumption: challenges and opportunities. *Indian J Community Med*. 2013;38:192–197.
5 India State-Level Disease Burden Initiative CVD Collaborators. The changing patterns of cardiovascular diseases and their risk factors in the states of India: the Global Burden of Disease Study 1990–2016. *Lancet Glob Health*. 2018;6:e1339–e1351.
6 Sachdev HS, Porwal A, Sarna A, et al. Intraindividual double-burden of anthropometric undernutrition and 'metabolic obesity' in Indian children: a paradox that needs action. *Eur J Clin Nutr*. 2021;75:1205–1217.
7 Moran AJ, Gu Y, Clynes S, Goheer A, Roberto CA, Palmer A. Associations between governmental policies to improve the nutritional quality of supermarket purchases and individual, retailer, and community health outcomes: an integrative review. *Int J Environ Res Public Health*. 2020;17:7493.
8 Steele-Adjognon M, Weatherspoon D. Double up Food Bucks program effects on SNAP recipients' fruit and vegetable purchases. *BMC Public Health*. 2017;17:946.
9 Sturm R, An R, Segal D, Patel D. A cash-back rebate program for healthy food purchases in South Africa: results from scanner data. *Am J Prev Med*. 2013;44:567–572.
10 Polacsek M, Moran A, Thorndike AN, et al. A supermarket double-dollar incentive program increases purchases of fresh fruits and vegetables among low-income families with children: the healthy double study. *J Nutr Educ Behav*. 2018;50:217–228.e1.
11 French SA, Rydell SA, Mitchell NR, Michael Oakes J, Elbel B, Harnack L. Financial incentives and purchase restrictions in a food benefit program affect the types of foods and beverages purchased: results from a randomized trial. *Int J Behav Nutr Phys Act*. 2017;14:127.
12 Phipps EJ, Braitman LE, Stites SD, et al. Impact of a rewards-based incentive program on promoting fruit and vegetable purchases. *Am J Public Health*. 2015;105:166–172.
13 Bihan H, Méjean C, Castetbon K, et al. Impact of fruit and vegetable vouchers and dietary advice on fruit and vegetable intake in a low-income population. *Eur J Clin Nutr*. 2012;66:369–375.
14 Turner C, Kalamatianou S, Drewnowski A, Kulkarni B, Kinra S, Kadiyala S. Food environment research in low- and middle-income countries: a systematic scoping review. *Adv Nutr*. 2020;11:387–397.
15 Kinra S, Radha Krishna K, Kuper H, et al. Cohort profile: Andhra Pradesh Children and Parents Study (APCAPS). *Int J Epidemiol*. 2014;43:1417–1424.
16 Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ*. 2008;337:a1655.
17 Glasgow RE, Harden SM, Gaglio B, et al. RE-AIM planning and evaluation framework: adapting to new science and practice with a 20-year review. *Front Public Health*. 2019;7:64.
18 Turner C, Aggarwal A, Walls H, et al. Concepts and critical perspectives for food environment research: a global framework with implications for action in low- and middle-income countries. *Glob Food Secur*. 2018;18:93–101.
19 Surendran S, Selvaraj K, Turner C, et al. Characterising the fruit and vegetable environment of peri-urban Hyderabad, India. *Glob Food Secur*. 2020;24:100343.
20 Coates J, Swindale A, Bilinsky P. *Household food insecurity access scale (HFIAS) for measurement of food access: indicator guide: Version 3: (576842013-001)*. 2007. https://doi.org/10.1037/e576842013-001.
21 National Family Health Survey. http://rchiips.org/nfhs/volume_2.shtml. Accessed April 6, 2020.
22 Kenward MG, Roger JH. Small sample inference for fixed effects from restricted maximum likelihood. *Biometrics*. 1997;53:983–997.
23 Hooper R, Forbes A, Hemming K, Takeda A, Beresford L. Analysis of cluster randomised trials with an assessment of outcome at baseline. *BMJ*. 2018;360:k1121.
24 Amrhein V, Greenland S, McShane B. Scientists rise up against statistical significance. *Nature*. 2019;567:305–307.
25 Vlaev I, King D, Darzi A, Dolan P. Changing health behaviors using financial incentives: a review from behavioral economics. *BMC Public Health*. 2019;19:1059.
26 Prell M, Smallwood D. Comparing alternative economic mechanisms to increase fruit and vegetable purchases. *U S Dep Agric Econ Inf Bull Number*. 2017;170:33.
27 Purnell JQ, Gernes R, Stein R, Sherraden MS, Knoblock-Hahn A. A systematic review of financial incentives for dietary behavior change. *J Acad Nutr Diet*. 2014;114:1023–1035.
28 Mozaffarian D, Liu J, Sy S, et al. Cost-effectiveness of financial incentives and disincentives for improving food purchases and health through the US Supplemental Nutrition Assistance Program (SNAP): a microsimulation study. *PLoS Med*. 2018;15:e1002661.