Obesity Research & Clinical Practice xxx (xxxx) xxx

Contents lists available at ScienceDirect

Obesity Research & Clinical Practice

journal homepage: www.elsevier.com/locate/orcp

Unhealthy, but not healthy, positional nudge during Ramadan affects the caloric content of meal choice among Indonesians with high BMI

Felix Yong Peng Why [a,1], Anna Undarwati [b,2,*], Pradipta Christy Pratiwi [b,3], Binta Muti'ya Rizki [b]

[a] University of Worcester, United Kingdom
[b] Universitas Negeri Semarang, Psychology Department, Indonesia

ARTICLE INFO

Keywords:
Diet
Dual process theory
Fasting
BMI
Food choice
Nudge

ABSTRACT

We tested for an asymmetric effect of food positional nudge biased towards the unhealthy for individuals with different BMI and fasted states. Data from 141 Indonesian participants were analysed. Participants completed the single-person Fake Food buffet twice, which offered healthy (e.g., roasted chicken) and unhealthy (e.g., fried chicken) options. Ramadan fasting was incorporated as a natural experimental condition by having participants complete the buffet during non-Ramadan and Ramadan periods. In addition, participants were randomly assigned to one of three positional nudge experimental conditions: control, healthy, and unhealthy. Control positional nudge had a balanced 2-to-2 healthy-unhealthy food placement in the buffet. In contrast, the healthy positional nudge had a starting 3-to-1 ratio, biased towards healthier food options, placed at the start of the buffet. The unhealthy positional nudge had a 3-to-1 starting ratio, biased towards more unhealthy options. The main results revealed an asymmetric effect that is biased towards an unhealthy positional nudge for fasted participants with high BMI. This bias was not reversed with a healthy positional nudge. The present findings raise questions about whether healthy positional nudges alone are sufficient in contexts involving high hunger and individuals with higher BMI, although further research with larger samples and more precise designs is needed before drawing policy conclusions.

1. Introduction

There is a global obesity epidemic - a meta-analysis by Wong et al. [1] found that the global prevalence of obesity has increased substantially from 1985 to 2014, from 31.3% to 48.3%. Indonesia, one of the largest and most populous countries in Southeast Asia, has seen an increase in adult overweight prevalence from 17.1% to 33% [2]. The retail environment, which grants people easy access to high-calorie food choices, has been examined within the context of positional nudging (i.e., making specific dietary choices more accessible to the person) [3]. While it might be intuitive to propose that a reversal of this is to replace easy access to unhealthy food choices with healthy options, most research has not examined this in relation to BMI.

Positional nudges have been reported to be effective in changing dietary choices [4]. However, some research examined the impact of positional nudge on dietary choice by comparing nudge with a non-nudge condition operationalised as a situation where the nudge material was absent, rather than one without any preferential bias towards healthy or unhealthy options [5]. Comparing a healthy or unhealthy nudge intervention to a control condition with a balance of healthy and unhealthy options is crucial for testing the asymmetric effects of a healthy nudge intervention. If positional nudge is theorised to work via physical proximity alone, consumers would be more likely to pick whichever type of food (regardless of how healthy it is) that is placed the closest. Secondly, regarding food policy and implementation science, if positional nudges work solely via proximity, reversing the obesogenic environment found in many impoverished communities would involve substituting easily accessible unhealthy food with healthy

* Correspondence to: Psychology Department, Faculty of Education and Psychology, Universitas Negeri Semarang, 2nd floor A1 Building, Sekaran, Gunungpati, Semarang, Central Java, Indonesia.

E-mail address: anna.undarwati@mail.unnes.ac.id (A. Undarwati).

[1] https://orcid.org/0000-0002-2937-225X
[2] https://orcid.org/0000-0002-2286-6089
[3] https://orcid.org/0000-0003-4189-6280

https://doi.org/10.1016/j.orcp.2026.07.001
Received 4 June 2025; Received in revised form 1 July 2026; Accepted 7 July 2026

food. However, the causal evidence for this remains lacking [6]. For example, shifting high-fibre cereals placed on eye-level shelves in seven retail stores did not result in more purchases [7]. On the contrary, the study reported a significant decline in high-fibre cereal sales and an increase in regular cereal purchases in these stores.

In the current study, we examined BMI as an individual difference moderator because emerging evidence suggests that hunger might exacerbate the asymmetric effect of positional nudge towards unhealthy dietary choices for people with high BMI. People with high BMI have a preference for unhealthy foods [8]. McKenna et al. [9] also found that during a food-deprived state, people with higher BMI were more likely to have an automated hunger response to unhealthy foods. This evidence supports our hypothesis that in a fasted state, people with higher BMI will exhibit a more significant asymmetric bias towards unhealthy than healthy or balanced positional nudges. In our study, we utilised religious fasting observed by Muslims during Ramadan to elicit higher levels of hunger.

Ramadan is a religious fasting observed by Muslims, which constitutes 25.6% of the world's population [10]. Ramadan lasts approximately one month. During Ramadan, Muslims do not drink or eat from dawn to sunset. Exceptions to Ramadan observance are granted for age, illness, and menstruation. Given differences in daylight hours across geographical regions and seasons, fasting during Ramadan could last 6–18 h. A recent meta-analysis reported an average reduction in calorie intake during Ramadan, though significant heterogeneity was observed, suggesting the presence of moderators [11]. The typical procedure in food decisional research is for participants to fast for 4 h before a food-choice task, which elicits moderate levels of self-reported hunger. However, during Ramadan fasting, self-rated hunger increases significantly over time from a moderate level of self-reported hunger (e.g., about 40 out of a 100-point rating scale) after four hours of fasting to 1.5 times higher after eight hours of fasting [12]. To our knowledge, no studies have investigated the efficacy of a positional nudge on dietary behaviour in individuals in a prolonged fasted state induced by Ramadan fasting. Hunger is an important consideration in a person's self-regulation of dietary behaviours [13]. Ramadan fasting, hence, is helpful for systematically examining the impact of higher levels of hunger on dietary behaviour change interventions in individuals with varying BMI.

2. Subjects

The target sample size of 84 was based on power statistical analysis using G*Power for an effect size of $f = .20$, $\alpha = .05$, power $= .90$, to detect a between-within predictor interaction. The effect size was determined via a previous meta-analysis for all types of nudge interventions at Cohen's $d = .40$ [14]. Participants who engaged in Ramadan fasting and had no dietary restrictions were eligible for this study. One hundred and forty-four Indonesian undergraduates volunteered for this study. We recruited participants in anticipation of sample attrition (e.g., change of fasting status due to menstruation or illness). However, only three participants could not complete the study due to scheduling difficulties. This resulted in data being analysed from 141 participants: 99 (70%) were women, and 42 were men. Random allocation was done by P.C.P. and B.M.R. using www.randomiser.org. F. Y.P.W. and A.U., who analysed the data, were blind to the allocation of participants. Gender representation was not significantly different across the three between-participant positional nudge conditions, χ^2 (2, $N = 141$) $= 1.49$, $p = .47$, $\varphi = .10$, indicating the successful random allocation to the three positional nudge conditions for gender. Average (*SD*) age of the participants was 19.53 years (1.62). The Institutional Review Board approved this study (Reference number 502/KEPK/FK/-KLE/2024). This study is not pre-registered.

3. Materials and Method

3.1. BMI

BMI was measured using a clinically validated stadiometer and weighing scale: SECA−213 and SECA−875. The mean (*SD*) BMI was 22.18 kg/m^2 (5.86). A one-way ANOVA revealed no significant BMI difference among the three between-participant positional nudge conditions, $F(2, 138) = 0.64$, $p = .53$, $\eta^2 = .009$ (see Table 1). This indicates that the random allocation to the positional nudge conditions successfully controlled for BMI. Using the BMI range of 18.5–24.9 kg/m^2 to define a healthy BMI, 26 participants (18.4%) were underweight, 86 (61%) were of a healthy weight, and 29 (20.6%) were overweight or obese. BMI was analysed as a continuous predictor.

3.2. Hunger

Each participant self-reported their hunger levels using a 5-point Likert scale from 1 (Not hungry at all) to 5 (Extremely hungry) each

Table 1
Mean Frequency (%) of each Fake Food Buffet item being selected by Nudge Condition*.

	Nudge Condition			Overall
	Control $n = 47$	Healthy $n = 48$	Unhealthy $n = 46$	$N = 141$
	Healthy Food Items			
Roasted Chicken	24 (51.1%)	21 (43.8%)	23 (50%)	68 (48.2%)
Boiled Cauliflowers	27.5 (58.5%)	20 (41.7%)	15 (32.6%)	62.5 (44.3%)
Boiled Beef Balls	21 (44.7%)	20.5 (42.7%)	22.5 (48.9%)	64 (45.4%)
Steamed Rice	34.5 (73.4%)	29.5 (61.5%)	22.5 (48.9%)	86.5 (61.3%)
Boiled Carrots	30 (63.8%)	27 (56.3%)	19.5 (42.4%)	76.5 (54.3%)
Boiled Potatoes	13 (27.7%)	11 (22.9%)	7.5 (16.3%)	31.5 (22.3%)
Apples (Red/Green)	20.5 (43.6%)	16 (33.3%)	17 (37%)	53.5 (37.9%)
Bananas	24 (51.1%)	19 (39.6%)	15.5 (33.7%)	58.5 (41.5%)
Mineral Water	40.5 (86.2%)	34.5 (71.9%)	32.5 (70.7%)	107.5 (76.2%)
Juices (Guava/ Raspberry)	12.5 (26.6%)	12.5 (26.6%)	12 (26.1%)	37 (26.2%)
Unsweetened Tea	4 (8.5%)	4.5 (9.4%)	4.5 (9.8%)	13 (9.2%)
Unsweetened Coffee	1.5 (3.2%)	1 (2.1%)	1 (2.2%)	3.5 (2.5%)
	Unhealthy Food Items			
Fried Chicken Leg	13.5 (28.7%)	18 (37.5%)	18.5 (40.2%)	50 (35.5%)
Fried Chicken Thigh	5.5 (11.7%)	6.5 (13.5%)	7.5 (16.3%)	19.5 (13.8%)
Fried Cauliflowers	8.5 (18.1%)	15.5 (32.3%)	10.5 (22.8%)	34.5 (24.5%)
Fried Beef Sausages	27 (57.4%)	36.5 (76%)	31 (67.4%)	94.5 (67%)
Fried Rice	4 (8.5%)	5 (10.4%)	6 (13%)	15 (10.6%)
Fried Carrots	7.5 (16%)	7 (14.6%)	10 (21.7%)	24.5 (17.4%)
Fried Potatoes/Chips	22 (46.8%)	27 (56.3%)	23 (50%)	72 (51.1%)
Crisps (Seaweed)	2.5 (5.3%)	4 (8.3%)	3 (6.5%)	9.5 (6.7%)
Crisps (Beef)	2.5 (5.3%)	3 (6.3%)	4 (8.7%)	9.5 (6.7%)
Muffin (Chocolate)	11 (23.4%)	21.5 (44.8%)	22 (47.8%)	54.5 (38.7%)
Muffin (Fruit)	9 (19.1%)	9.5 (19.8%)	4 (8.7%)	22.5 (16%)
Soda (Cola)	0.5 (1.1%)	0 (0%)	0.5 (1.1%)	1 (0.7%)
Soda (Sprite)	0 (0%)	1 (2.1%)	1 (2.2%)	2 (1.4%)
Sweetened Tea	2.5 (5.3%)	7.5 (15.6%)	5.5 (12%)	15.5 (11%)
Sweetened Coffee	1.5 (3.2%)	2 (4.2%)	3.5 (7.6%)	7 (5%)

* Mean frequencies are the average food selection for both non-Ramadan and Ramadan periods (raw data in supplementary materials).

time before they completed the Fake Food Buffet.

3.3. Ramadan Fasting

Data was collected between February 2024 and April 2024. All participants completed the Fake Food Buffet twice – once during the non-Ramadan/non-fasting period, defined as the month preceding (i.e., February to early March) and immediately after Ramadan (i.e., April 2024). The fasting period was Ramadan: 12th March to 9th April 2024. Half of the participants in this study completed the Fake Food Buffet in the non-Ramadan period first and then the Ramadan period, while the other half completed the Fake Food Buffet during Ramadan first, then post-Ramadan. Data collection was restricted to weekdays between 12 noon and 5 pm. This is because, based on our informal interviews with individuals who practice Ramadan, this period is when hunger is particularly poignant.

3.4. Fake Food Buffet, Positional Nudge, and estimated caloric content of the chosen meal

The dietary calories of the meal chosen by each participant were estimated using the single-person Fake Food Buffet [15], which consisted of 24 food options: 14 realistic plastic replicas of food (e.g., fried chicken) and ten pre-packaged real food items (packets of crisps; Fig. 1). Bucher et al. [16] reported that calories from food chosen using the Fake Food Buffet correlated with real food at.76 (chicken) to.87 (beans) and has a test-retest reliability of.80. Our version of the Fake Food Buffet has 12 unhealthy and 12 healthy items. Healthy food items were prepared using the same primary ingredient (e.g., chicken) in a manner that lowered its caloric content (i.e., roasted vis-à-vis fried) or did not contain added sugar (e.g., non-sweetened beverages). Items were from a balanced macronutritional profile consisting of carbohydrate-rich foods (e.g., rice), protein-rich foods (e.g., beef), and fibre-rich foods (e.g., cauliflower). Printed food labels were placed in front of each food item to enable participants to identify the individual food items. For pre-packaged food items (e.g., a bottle of soda), the caloric content was estimated using the nutritional information on the food packaging. For the plastic food replicas (e.g., fried chicken), calories were estimated using the nutritional information based on the identical portion size of real food equivalents. For example, the plastic replica of a fried chicken leg was estimated using an equivalent-sized item from Iceland Southern fried drumsticks. The real food equivalent was weighed, and its estimated calories were derived using this product's nutritional information. Details of the caloric estimation of the plastic food replicas in the Fake Food Buffet have been reported elsewhere [15]. Indonesians are familiar with the buffet-style food presentation [17], as well as the collection of Asian (rice) and Western (chips) food items [18]. Indonesians also frequently eat ready-made meals [19].

Fig. 1. One-person fake food buffet setup for healthy positional nudge.

Food items were placed sequentially in a U-shaped table measuring 10.5 m in length, and the table width was 75 cm. Participants were instructed to start at one end of the table (bottom left corner in Fig. 1) and walk along the outer edge of the table to make their dietary selection from the Fake Food Buffet (Table 1). This protocol replicates a buffet setup for a single participant where different types of food are often presented sequentially [20]. This sequential presentation of food options is also relevant and generalizable to product placement in a store layout, based on how people traverse the store [21].

3.5. Positional Nudge

Participants were randomly assigned to one of three between–participant conditions: control, healthy, or unhealthy positional nudge. In the control condition, healthy and unhealthy food options were placed in a 2–2 balanced sequence (two healthy food options followed by two unhealthy food options). Specifically, participants in this control condition were exposed to the following presentation order for the food options (H = Healthy, UH = Unhealthy): roasted chicken (H), steamed plain rice (H), fried cauliflowers (UH), fried rice (UH), boiled beef balls (H), boiled potatoes (H), fried beef sausages (UH), fried chicken (UH), boiled carrots (H), boiled cauliflowers (H), fried carrots (UH), fried potato/chips (UH), apples (H), bananas (H), crisps (UH), chocolate muffin (UH), juices (H), water (H), fruit muffin (UH), sweetened tea (UH), plain tea (H), plain coffee (H), sweetened coffee (UH), sodas (UH). For participants assigned to the healthy positional nudge condition, healthy food options were placed with a starting ratio of 3-to−1 to unhealthy food options at the start of the buffet, which gradually decreased. This is because the same 24 food options were in the Fake Food Buffet regardless of the sequence in which they were placed. Specifically, participants in this condition were presented with the following sequence of food options (H = Healthy, UH = Unhealthy): roasted chicken (H), boiled cauliflowers (H), boiled beef balls (H), fried chicken (UH), plain steamed rice (H), boiled carrots (H), boiled potatoes (H), fried cauliflowers (UH), apples (H), bananas (H), water (H), fried carrots (UH), juices (H), plain tea (H), plain coffee (H), fried potato/chips (UH), fried beef sausages (UH), fried rice (UH), crisps (UH), chocolate muffin (UH), fruit muffin (UH), sweetened tea (UH), sweetened coffee (UH), sodas (UH). For the unhealthy positional nudge condition, participants were assigned to the sequence of food options that placed more unhealthy options at the start of the buffet in the same starting ratio of 3-to−1 (H = Healthy, UH = Unhealthy): fried chicken (UH), fried cauliflowers (UH), fried carrots (UH), roasted chicken (H), fried potatoes/chips (UH), fried beef sausages (UH), fried rice (UH), boiled cauliflowers (H), crisps (UH), chocolate muffin (UH), fruit muffin (UH), boiled beef balls (H), sweetened tea (UH), sweetened coffee (UH), sodas (UH), plain steamed rice (H), boiled carrots (H), boiled potatoes (H), apples (H), bananas (H), juices (H), water (H), plain tea (H), plain coffee (H).

3.6. Procedure

Participants during the non-Ramadan period were asked to abstain from eating four hours prior. During Ramadan, participants were not instructed to do this because adherence to Ramadan meant that they would not have eaten since approximately 4:30 am. The researcher confirmed participants' adherence to the four-hour (non-Ramadan) or Ramadan fasting when they met each participant in the research room. If a participant completed the Fake Food Buffet at 1 pm during non-Ramadan, they also completed the same task at 1 pm during Ramadan. The test-retest time lag was approximately three to four weeks between the non-Ramadan and the Ramadan data collection for each participant. The researcher met the participants individually in the research room, where informed consent was obtained. Afterwards, participants' height and weight were measured, and they were instructed to complete the Fake Food Buffet. After completing the Fake

Food Buffet, a picture of the meal was taken. Each participant was debriefed at the end of the second data collection.

4. Results

4.1. Fasting Period Manipulation Check: Predicting Self-Rated Hunger

A mixed model analysis was conducted using Jamovi (v. 2.6; www.jamovi.org) with participant ID as a random factor. A copy of the data and complete results has been provided as supplementary material. Self-rated hunger was predicted using these fixed factors: Fasting Period (non-Ramadan versus Ramadan), Positional Nudge Condition (Healthy-Unhealthy-Control), and BMI. Marginal R^2 was.282, and Conditional R^2 was.284. The main effect for Positional Nudge Condition was non-significant, $F(2, 135) = 0.11$, $p = .91$. This indicated that randomising participants to the Positional Nudge Conditions was effective in controlling for overall self-rated hunger. Only a Fasting Period main effect, $F(1, 135) = 98.63$, $p < .001$, Estimate(SE) = 1.166(0.117), and a Fasting Period X BMI two-way interaction effect, $F(1, 135) = 4.50$, $p = .036$, Estimate(SE) = 0.044(0.021), were statistically significant (Table 2). Post hoc examination of these results revealed that self-rated hunger was higher during Ramadan fasting, *EMM*(SE) = 4.05(0.08), than during the non-Ramadan period, *EMM*(SE) = 2.89(0.08). This indicated that Fast Period was effective in eliciting higher self-rated hunger. The Fast Period X BMI interaction indicated that BMI predicted self-rated hunger negatively during the non-fasting period, but this effect was significantly attenuated during Ramadan fasting (Fig. 2).

4.2. Main Analysis: Predicting Caloric Content of Chosen Meal

We tested the same model predicting the estimated caloric content of the participants' chosen meal. The marginal R^2 was.05, and the conditional R^2 was.55. The three-way interaction for Fasting Period X Positional Nudge X BMI was significant, $F(2, 135) = 3.34$, $p = .038$. Bonferroni control for Type 1 error was done for post hoc comparisons, $\alpha = .05/2 = .025$. Examination of its estimates revealed that the Fasting Period X BMI interaction was significantly different between the Control and Unhealthy Positional Nudge conditions, Estimate(SE) = 23.52 (9.09), $t(135) = 2.59$, $p = .01$ (Fig. 3), but was not significantly different between the Control and Healthy Positional Nudge conditions, Estimate (SE) = 9.11(9.71), $t(135) = 0.94$, $p = .35$. We conducted TOST procedures to examine whether the observed effects were statistically equivalent to a small effect size ($d = \pm 0.20$). Using our observed generalised Cohen's d [22], 0.32, the upper boundary test was non-significant, $t(135) = 0.94$, $p = .83$, whereas the lower boundary test was significant, $t(135) = 4.23$, $p < .001$. We used the same procedure to perform an equivalence test for the non-significant result using the observed $d = 0.11$, and found no evidence for equivalence to a small effect size, upper boundary $t(135) = -.71$, $p = .24$, lower boundary $t(135) = 2.59$, $p = .99$. Thus, there was no evidence that the effects were equivalent to a small effect size. The equivalence tests help evaluate whether the observed effects fall within a predefined smallest effect size of interest, but they do not address the study's a priori power for detecting such effects. Therefore, the non-equivalence of the healthy nudge contrast should not be taken as evidence that the effect is zero. Our data are consistent with the hypothesised asymmetric pattern for unhealthy nudges among individuals with higher BMI during fasting, although the precision of the estimates warrants cautious interpretation. The healthy positional nudge did not produce a statistically detectable effect in this sample. Given the study's precision constraints, this null result should be interpreted cautiously as uncertainty rather than evidence of absence. No other effect was statistically significant, p's = .98–.11. For example, the Positional Nudge main effect was $F(2, 135) = 0.91$, $p = .40$, and the Positional Nudge X BMI interaction was $F(2, 135) = 2.19$, $p = .12$. The significant Fasting Period X Positional Nudge X BMI interaction for estimated calories is unlikely to be explained by hunger: this three-way interaction was non-significant for self-rated hunger, $F(2, 135) = 1.79$, $p = .17$.

We performed a Monte Carlo sensitivity analysis across a wide array of hypothetical parameter weights (beta = 5–35, based on 200 structural simulation iterations per node) to observe exactly where our design achieves the standard 80% statistical power threshold (see supplementary materials). For the 3-Way Comparison (Healthy Nudge vs. Control Contrast over BMI and Fasting Period), the simulation revealed that our design achieved the conventional 80% statistical power threshold at an unstandardized interaction effect size of beta = ~28.5. Our empirically observed effect for this specific contrast was beta = 9.11 ($p = .35$). This renders the null finding statistically inconclusive due to design precision constraints rather than evidence of an absent effect. For the Significant Comparison (Unhealthy Nudge vs. Control Contrast over BMI and Fasting Period), by contrast, our observed significant effect size for the unhealthy-nudge comparison was beta = 23.52 ($p = .010$). Hence, this finding is plausible.

Table 2
Mean (SD) for BMI, Self-Rated Hunger, and Estimated Calories of Chosen Meal by Positional Nudge condition and Fasting Period, N = 141.

Position Nudge	BMI, kg/m^2	Fasting Period			
		Non-Fasting		Fasting (Ramadan)	
		Hunger	Calories, kcal	Hunger	Calories, kcal
Control, $n = 47$	22.2 (6.91)	2.94 (1.01)	775 (230)	3.94 (0.85)	802 (284)
Healthy, $n = 48$	22.8 (4.94)	2.88 (1.20)	840 (274)	4.06 (0.86)	876 (280)
Unhealthy, $n = 46$	21.5 (5.61)	2.91 (1.17)	834 (264)	4.15 (0.82)	843 (316)

5. Discussion

In this study, we tested the hypothesis of the impact of healthy and unhealthy positional nudge on the estimated caloric content of the chosen meal among people with varying BMI and fasted states. We found an asymmetric effect for unhealthy food positioning among people with high BMI in a fasted state that is not reversed by a healthy food positional nudge. Given this asymmetric effect that is biased towards unhealthy food choices, our results suggest reconsidering whether the solution to an obesogenic environment (i.e., unhealthy positional nudge) is to have more accessible healthy food options (i.e., healthy positional nudge), particularly for people at risk of obesity.

The research on the impact of Ramadan fasting on caloric intake has significant heterogeneity [11]. Consistent with the results of the meta-analysis, the existence of a complex interaction in our study suggests that the impact of Ramadan fasting on overall caloric intake, like the impact of positional nudge, is contextually dependent. This could also explain the inconsistent results for positional nudge. A healthy positional nudge has been touted as a potential solution to the obesogenic environment to address the obesity epidemic. To our knowledge, we believe our study is the first to experimentally test this using a balanced control condition, thereby extending observational data on the use of this approach to reverse the impact of an obesogenic environment for individuals with or at risk of obesity. The three-way interaction found in our study suggests that while an unhealthy positional nudge may be obesogenic, our design lacked the statistical precision required to confirm or rule out a corresponding counter-effect for the healthy positional nudge.

This asymmetric effect, which is biased towards larger quantities of unhealthy food placed at the start of a buffet for individuals with higher BMI in a fasted state, is congruent with other research areas and is known as the negativity bias effect – negative factors have a stronger influence on behaviours than positive factors [23]. Our results suggest that fasting might increase this negativity bias among people high in

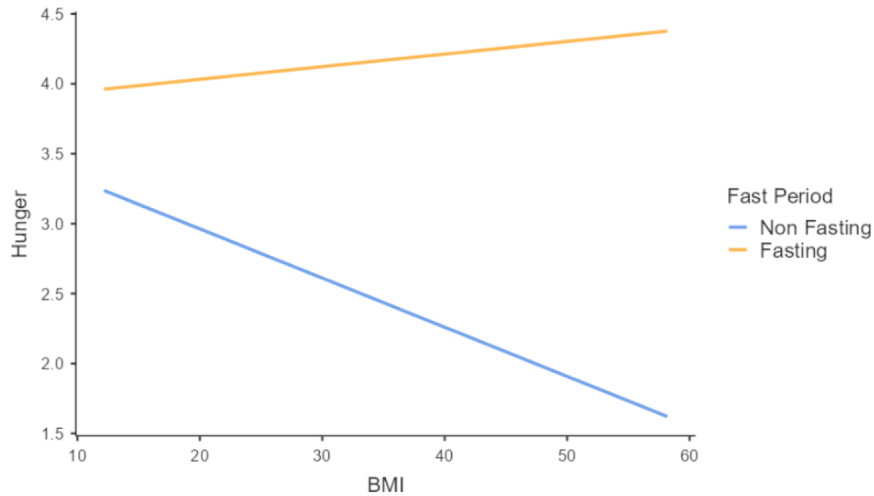

Fig. 2. Self-rated hunger predicted as a function of BMI and Fast Period, N = 141.

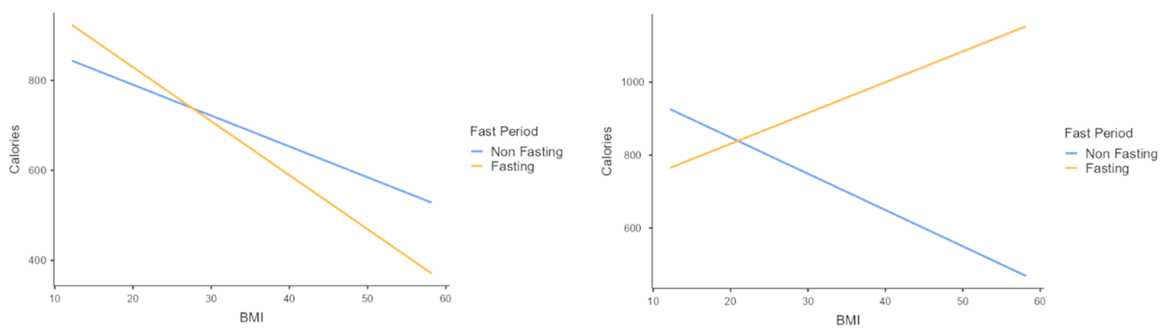

Fig. 3. Estimated calories of participants' chosen meal as a function of BMI and Fasting Period for the control positional nudge condition (left) and the unhealthy positional nudge condition (right), N = 141.

BMI. Starvation results in ego-depletion, which might result in people failing to regulate their dietary behaviours [24,25]. In the context of our study, given that people with high BMI might have a preference towards unhealthy food [8], fasting might have resulted in them succumbing to this propensity, particularly when more unhealthy food options are placed at the start of the buffet line. Our study has some limitations. Firstly, Although the study was powered for a medium-sized between–within interaction based on prior meta-analytic estimates of general nudge effects, higher order interactions such as the Fasting Period × Positional Nudge × BMI effect typically require substantially larger samples for stable estimation. Recent methodological work highlights that interaction effects are often smaller and more variable than main effects [26]. Thus, the present design may have limited precision for detecting small but theoretically meaningful effects, particularly for the healthy nudge contrast. Secondly, we measured dietary choice using a single assessment session for the non-fasting and fasting periods. This was because Ramadan, which served as a natural experimental condition for fasting, occurred over a short period. This provided some challenges to assessing dietary choices more than once for each participant during Ramadan. Future research might examine this among people who engage in chronic food deprivation to examine the long-term effects of healthy and unhealthy positional nudge. Thirdly, we also did not assess the number of days of fasting observed for each participant, nor did we consider other related factors such as sleep quality [33] and non-exercise activity thermogenesis [34], which may need to be statistically controlled for in future studies. Lastly, we did not collect independent measures of food liking or baseline choice under neutral conditions. Because caloric selection is strongly influenced by subjective value [27,28], we cannot fully rule out the possibility that pre-existing preferences interacted with the positional manipulation. Although randomisation reduces systematic bias on average, it does not guarantee balance on unmeasured psychological variables in samples of this size. Although behavioural choice reflects revealed preference in context, it does not substitute for an independent measure of liking. Future work should include pre-intervention preference assessments to disentangle positional effects from individual differences in food valuation. The present design should be explicitly characterised as an initial, suggestive investigation that remains underpowered for detecting the true magnitude of healthy positional choice-architecture adjustments. Applied conclusions or policy recommendations regarding the healthy-nudge arm are unwarranted until replication in an adequately powered sample is achieved.

Funding

This research was supported by the Institute of Research and Community Service, Universitas Negeri Semarang, Republic of Indonesia (ID: 109.26.2/UN37/PPK.10/2024).

Ethical Statement

The study reported in this manuscript has been approved by the Institutional Review Board (Reference number 502/KEPK/FK/KLE/2024). Informed consent was obtained from all participants at the first point of contact, and all participants had the right to withdraw at any point in their participation.

CRediT authorship contribution statement

Why Felix: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Binta Muti'ya Rizki:** Writing – review & editing, Visualization, Resources, Project administration, Investigation, Funding acquisition, Data curation. **Pradipta Christy Pratiwi:** Writing – review & editing, Visualization, Resources, Project administration, Investigation, Funding acquisition, Data curation. **Anna Undarwati:** Writing – review & editing, Visualization, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Author Agreement

The authors of this manscript agree to the following:

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Declaration of Competing Interest

The authors of this manuscript have nothing to declare.

Acknowledgements

F. Y. P. Why and A. Undarwati are joint first authors.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.orcp.2026.07.001.

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