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Home-delivered meal programme participants may be at greater risk of malnutrition without the meal programme

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Abstract

Objectives: (1) To examine total quality of foods consumed on the day a home-delivered meal (HDM) of the Older Americans Act Nutrition Program (OAANSP) was served, and when a HDM was not served; and (2) to estimate proportion of HDM participants and non-participants meeting the daily average recommendations for guidance-based foods and nutrients.
Design: Cross-sectional study.
Setting: Data were obtained from the national 2015–2017 Outcomes Evaluation Study of HDM participants in the USA.
Participants: Adults aged 67 years and older (*n* 1227), 620 HDM recipients and 607 matching non-participants examined in three groups: (1) meal recipients who received a HDM on the day of the 24-h dietary recall; (2) no-meal recipients who did not receive a HDM on the day of the recall and (3) matching HDM non-participants.
Results: Healthy Eating Index (HEI)-2010 scores of HDM participants were significantly lower on the day the meal was not received compared with when a meal was received (52·5 *v.* 63·4, $P < 0·0001$). There was no significant difference in the total HEI-2010 scores of HDM meal recipients and HDM non-participants. Despite the meal, less than 20 % of HDM participants and non-participants met the 2010-Diet Guidelines for Americans recommended average daily intake for fruit, vegetables, dairy, protein foods and solid fats.
Conclusion: HDM participants' diet quality is poorer when they do not receive a meal putting them at increased risk of malnutrition. Expanding the OAANSP to offer meals on weekends and/or to include more than one meal/d is recommended to improve the diet of this vulnerable population.

Keywords
Older adults
Diet quality
Food security
Home-delivered meals
Food assistance

Adults aged 65 years and older are growing in number and are living longer[1,2]. However, within this age group, those with self-reported ambulatory disabilities who tend to be homebound (19·6 %) are considered the fastest growing subpopulation[3]. This subpopulation tends to be older, has poorer health, higher comorbidities and is at higher risk of malnutrition, which results in higher healthcare utilisation and cost[3,4].

To prevent or alleviate malnutrition, the Nutrition Service Program under the Older Americans Act Nutrition Program (OAANSP) of the Administration for Community Living provides nutrition services to vulnerable older adults to maintain and promote their dignity and independence[5]. OAANSP is the largest federal programme for home-based nutrition services and delivers meals (referred to as home-delivered meals (HDM)) to older adults who are homebound. Five meals are typically provided per week, delivered either daily on weekdays or once a week, as frozen meals, and these meals must comply with the Dietary Guidelines for Americans (DGA), and provide at least one-third of the Dietary Reference Intakes established by the Food and Nutrition Board of the Institute of Medicine[5]. Although this meal is an important contributor to daily intake, individuals must consume, ideally, an additional two-thirds of daily requirement to satisfy their overall dietary needs.

As the older population is expanding, so is the need for this programme. This is reflected in the increasing number of people on waiting lists across the country. Yet, funding has not matched that increasing need[2,5,6]. This gap in

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funding is arguably the result of limited evidence regarding the effectiveness of the OAANSP in decreasing medical costs and institutionalisation[6]. Much of the literature on the population receiving HDM is limited to specific groups of participants (e.g. older adults with hypertension) or confined to certain geographic locations, making findings less generalisable[7,8]. Nevertheless, findings from these studies suggest that participation in HDM programmes is associated with a more nutritionally adequate diet[7,9]. However, less is known about the other food consumed by participants in addition to the HDM, on days when a meal is provided, and the composition of the food consumed by this population group on days when a meal is not provided. One study, albeit dated (1988)[10], indicated that foods consumed by HDM participants besides the delivered meals did not provide the rest of their nutrient requirements, and provided less than a third of the RDA for vitamin A, calcium and vitamin C.

In 2006, a congressional mandate was issued to evaluate the OAANSP. This mandate led to the 2015–2017 Outcomes Evaluation Study conducted by the Administration for Community Living, of the Department of Health and Human Services to examine the impact of the OAANSP meals on client outcomes[11]. Using these data, we examined the quality and quantity of HDM participants' overall diet. The specific objectives of the current study were to examine the quantity and quality of the foods consumed on a day the HDM was served and when a HDM was not served.

Methods

Study design

This study used secondary data of a nationally representative sample of HDM participants (*n* 627), and matching HDM non-participants (*n* 629) from the Outcomes Evaluation Study conducted in 2015–2017. Details on recruitment, sampling technique and exclusion criteria are described in details elsewhere[12]. Briefly, the Outcomes Evaluation Study used a multistage cluster sample design. Propensity scores were used to match HDM non-participants to HDM participants based on socio-demographic and health-related characteristics such as age, gender, race/ethnicity, Medicare and Medicaid eligibility, the presence of chronic conditions, Medicare service utilisation and Medicare expenditures Part A (hospital insurance, which covers inpatient care, skilled nursing facility care, nursing home care, hospice care and home-health care) and Part B (medical insurance, which covers medically necessary services and preventive services)[13]. However, the groups were not matched on homebound status[12].

Researchers in the Outcomes Evaluation Study used computer-assisted personal interviews to collect socio-demographic and health characteristics of individuals and their dietary intake. Respondents who did not have any dietary recall information (*n* 13) and those whose calculated energy intakes were ±3 SD of the mean (*n* 16) were excluded from this study, with a final total sample of 1227 respondents. Not all HDM participants received a meal on the day of the 24-h recall and therefore, study participants were classified into three groups: HDM participants who received a meal on the day of the 24-h recall (meal recipients) (*n* 533); HDM participants who did not receive a meal on the day of the 24-h recall (no-meal recipients) (*n* 87); and HDM non-participants as the control group (*n* 607). Oral consent was obtained from individuals who agreed to participate in the Outcomes Evaluation Study, and the Institutional Review Board approval was obtained from the New England Institutional Review Board (protocol number 120160370) by Mathematica, the survey contractor.

Socio-demographic and health-related characteristics

Age, sex, ethnicity, educational attainment, marital status, area of residence, number of meals consumed/d, appetite, dental problems, respondent's self-rated health, physician-diagnosed self-reported chronic conditions (hypertension, CHD, diabetes mellitus, cancer, allergies and other breathing or lung problems, stroke, high cholesterol, anaemia, osteoporosis and kidney disease)[14] and mobility were collected.

Household food security status was assessed using the validated six-item short form of the US Household Food Security Survey Module[15,16]. The score categorises individuals into having high or marginal food security (score = 0–1), low food security (score = 2–4) or very low food security (score = 5–6). This scale was dichotomised into food security and food insecurity (low and very low food security).

Outcome variables: dietary intake data

Interviewer-administered 24-h dietary recalls were collected from the entire sample and a second one was collected from a randomly selected subsample (*n* 123), using the 24-h (ASA24®) Dietary Assessment Tool[17]. The dietary recall was not always collected for the day the participant received a meal. The reason that the HDM participant did not receive a meal on the day of the 24-h recall was not reported. However, the data were not collected on a Monday and so the lack of HDM was not due to the weekend. The dietary recalls were analysed for nutrient values using the Food and Nutrient Database for Dietary Studies (version 4.1)[18] and food group values from MyPyramid Equivalent Database (version 1.0)[19]. Dietary quantity and quality were assessed as described below.

Diet quality assessment

Day 1 and day 2 24-h dietary recalls were used to estimate the mean Healthy Eating Index (HEI-2010) and

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its components using the population ratio method, which calculates mean scores at the population level providing less-biased usual mean scores compared with averaged person-level scores[20]. The HEI is a validated tool to evaluate diet quality in terms of its adherence to the DGA[21,22]. The HEI-2010 and the MyPyramid were used instead of the more recent HEI-2015 and MyPlate because the study was conducted before the release of the latter tools, and the HDM menus were designed to conform to the HEI-2010. The data were also compared with the HEI-2015 to assess differences. The HEI-2010 classifies foods into thirteen components. Nine components (total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids) are categorised as adequacy components (i.e. higher scores indicate higher consumption), and three (refined grains, sodium and empty calories) assess components for which moderate consumption is recommended (i.e. higher scores indicate lower consumption)[22]. The empty calories include solid fats, alcohols and added sugars (SoFAAS). The fatty acid component is computed as the ratio of unsaturated fatty acids to SFA and the empty calories component is presented as the percentage of energy. All of the other HEI components are calculated using a density basis of recommended serving size/1000 kcal[22]. The total HEI score represents the sum of the component scores with a maximum score of 100 points[23]. Higher intakes of adequacy components and lower intakes of moderation components indicate better compliance with the DGA and result in higher scores.

The HEI-2010 scores were estimated for intake by all three groups. Radar plots were constructed to help visualise all HEI component scores simultaneously. The outer edge of the radar plot represents 100 % of the maximum score and the centre of the circle represents a score of 0 %. The plots move from the centre outwards[24]. The plots were created to examine the HEI component scores to represent the 24-h dietary intake by HDM meal recipients, HDM no-meal recipients and non-participants.

Dietary intake compared with the 2010 Diet Guidelines for Americans

The percentage meeting the 2010 DGA average daily intake for fruits, vegetables, dairy, grains, proteins, calories from added sugars and calories from solid fats was assessed based on 2000 calories and over, and 1600 calories and over, for men and women aged 66 years and over, respectively. These are the estimated energy requirements to maintain energy balance for sedentary older adults[25]. Based on these estimated energy requirements, the recommended daily average intakes used in these analysis, by sex, were: fruit (women ≥ 1·5 cup equivalents; men ≥ 2 cup equivalents); vegetables (women ≥ 2 cup equivalents; men ≥ 2·5 cup equivalents); grains (women ≥ 5-ounce equivalents; men ≥ 6-ounce equivalents); protein foods (women ≥ 5-ounce equivalents; men ≥ 5·5-ounce equivalents); dairy (women ≥ 3 cup equivalents; men ≥ 3 cup equivalents); less than 10 % calories from solid fats and added sugars, and less than 2300 mg for Na. Calories consumed from added sugars and solid fats were estimated based on 16 calories/teaspoon of added sugars and 9 calories/g of solid fats, respectively.

Statistical analysis

To obtain estimates representative of this population, dietary sample weights were used to account for differential probabilities of selection, non-response, non-coverage and day of the week of the recall. Pairwise differences were tested using univariate *t* statistic in SAS-Callable SUDAAN Proc Descript procedure, P set at $< 0{\cdot}05$. Standard errors of the percentages were estimated using Taylor series linearisation[26], a method that incorporates the NHANES sampling design. Data were analysed using SAS (version 9.4; SAS Institute Inc.)[27] and SAS-Callable SUDAAN version 11.0 (RTI International)[28]. Analyses were adjusted for complex survey design[29].

Results

Sample characteristics

Eligible sample constituted 1256 respondents, with a final sample of 1227 respondents. The mean age of all study participants was 81·3 years and most were female (71·8 %), non-Hispanic white (73·5 %), were widowed, separated, divorced or never married (74·9 %) and lived in an urban residence (66·4 %) (data not shown). HDM non-participants were matched to HDM participants, and there were only few differences between these groups. These differences include significantly lower percentage of non-participants than HDM participants who lived in an urban area, and significantly higher percentage of non-participants who reported excellent health and were physically mobile (Table 1). Approximately one-third of both HDM participants and non-participants ate two meals or less/d, with more than one-fourth of them reporting fair/poor appetite. Almost one-fourth of HDM participants and more than one-fifth of non-participants reported having dental problems, and more than 80 % of HDM participants and non-participants stated having more than three chronic diseases.

Mean Healthy Eating Index of study participants

The total HEI-2010 for no-meal recipients was significantly lower than meal recipients (52·5 *v.* 63·4, respectively, $P < 0{\cdot}0001$). This was reflected in lower scores of no-meal recipients for total vegetables (3·3 *v.* 4·6 out of 5, $P = 0{\cdot}004$), seafood and plant proteins (2·3 *v.* 4·1 out of 5; $P = 0{\cdot}024$) and lower scores for solid fats, alcohol and added sugar (SoFAAS) (10·5 *v.* 12·8 out of 20, $P = 0{\cdot}016$). Additionally, no-meal recipients had a significantly lower overall diet quality compared with HDM non-participants (52·5 *v.*

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Table 1 Comparison of socio-demographic and health-related characteristics of HDM participants and non-participants: Outcomes Evaluation Study 2015–2017*

	HDM participants (*n* 620)		Non-participants (*n* 607)		
	n†	Weighted %	*n*†	Weighted %	*P*
Age (years)					
Mean	81·7		80·8		0·2318
SE	0·7		0·6		
Healthy eating index					
Mean	62·0		60·4		0·3985
SE	1·5		1·1		
Sex					
Male (*v.* females)	189	30·9	208	24·6	0·1032
Ethnicity					
Non-Hispanic white	482	72·0	485	75·5	0·5407
Non-Hispanic black	84	16·7	77	16·9	0·9749
Other race and Hispanic origin	54	11·3	45	7·7	0·2702
Education					
Less than 12th grade	250	38·9	145	36·3	0·6438
High school graduate/GED	173	28·8	169	28·3	0·9299
Some college or above	183	32·3	290	35·4	0·5559
Marital status					
Married/living with a partner (*v.* single)	143	23·8	274	26·9	0·4637
Residence					
Urban (*v.* rural)	381	75·3	336	54·5	0·0003
Food security					
Food insecure (*v.* food insecure)	148	24·2	97	17·6	0·1334
Meals consumed/d					
≤ 2 meals/d	201	33·4	206	36·6	0·8280
Appetite					
Excellent	166	26·3	219	31·5	0·4982
Good	287	46·1	254	41·8	0·2347
Fair/poor	160	27·6	123	26·7	0·3481
Dental problems					
Yes	155	24·7	101	21·8	0·2528
Self-rated health					
Excellent/very good	136	19·3	220	28·7	0·0421
Good	193	33·9	185	30·3	0·5217
Fair/poor	286	46·8	201	41·0	0·4092
Self-reported chronic diseases					
≤ 2 diseases (*v.* >3)	124	18·8	129	16·7	0·5480
Mobility					
Able to walk (*v.* inability)	554	89·7	594	96·4	0·0133

*Pairwise differences in proportions tested using univariate *t* test in SUDAAN Proc Descript procedure. Taylor series linearisation was used to compute variance estimates.
†Unweighted sample size; weighted column percentages unless otherwise specified.

60·4, respectively, $P < 0·0001$) reflected in lower scores of no-meal recipients for total vegetables (3·3 *v.* 4·4 out of 5, $P = 0·008$), seafood and plant protein (2·3 *v.* 4·4 out of 5, $P = 0·001$) and higher scores for SoFAAS (12·6 *v.* 10·5 out of 20, $P = 0·027$). There were no significant differences in total HEI scores of meal recipients and non-participants ($P = 0·138$), but meal recipients had higher scores than non-participants for dairy (7·4 *v.* 5·7 out of 10, $P = 0·001$) and refined grains (7·7 *v.* 6·3 out of 10, $P = 0·02$) (Fig. 1). Overall, the scores for Na and whole grains were quite low for all groups, indicating high Na and low whole grain intakes (Fig. 1). The correlation between the mean scores for HEI-2010 and HEI-2015 was 0·96 (data not shown).

Dietary intake of study participants compared with 2010-Diet Guidelines for Americans

On a given day, the percentage of HDM participants and non-participants who consumed the recommended average daily amounts was: (1) 18·4 % for fruit; (2) 14·0 % for vegetables; (3) 7·1 % for dairy; (4) 24·4 % for grains and (5) 15·8 % for protein foods. Furthermore, 11·8 % consumed less than 10 % calories from solid fats, 54·6 % consumed less than 10 % calories from added sugars and 40·1 % consumed less than 2300 mg of Na (Fig. 2). Significantly more meal recipients (19·9 %) and HDM non-participants (18·6 %) consumed the recommended daily average amounts for fruit than no-meal recipients (7·7 %). Also, significantly more meal recipients (9·5 %) consumed the recommended average daily amounts for dairy, than no-meal recipients (2·4 %) and HDM non-participants (5·1 %). Finally, significantly more HDM non-participants consumed the recommended daily average amounts for vegetables (15·5 %) and grains (28·8 %), than no-meal recipients, and a significantly larger percentage of HDM non-participants (44·9 %) consumed the recommended Na amounts than meal recipients (35·0 %).

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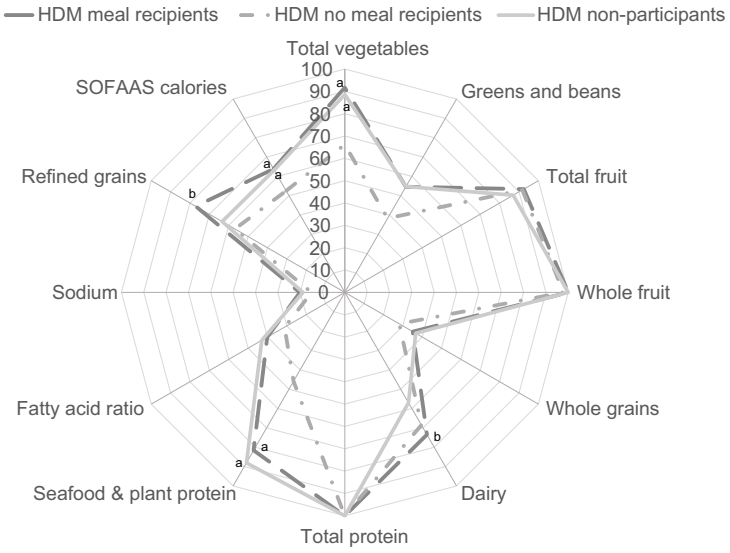
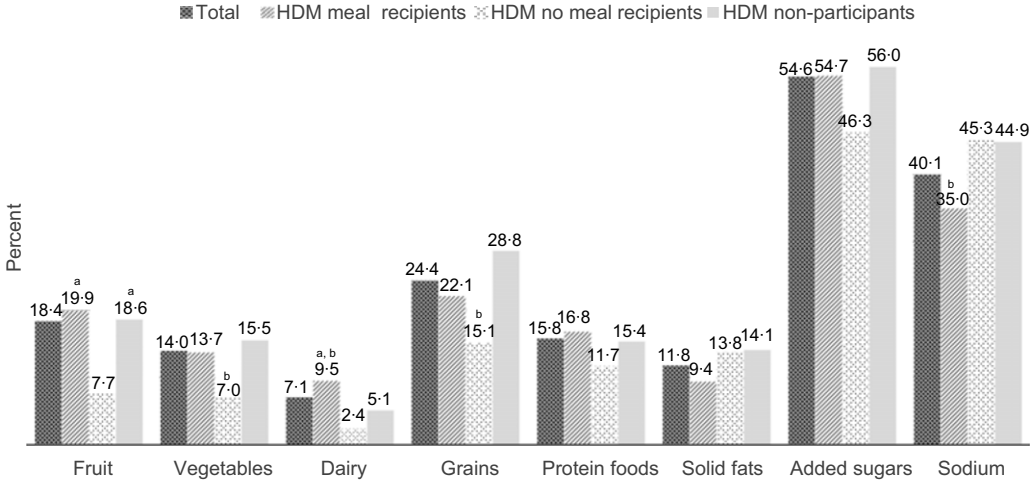


[a] Significantly different from HDM no meal recipients.
[b] Significantly different from HDM non-participants.
Pairwise differences between groups were tested using univariate *t* statistic, p set at <0·05.

Fig. 1 HEI-2010 Component scores of HDM meal recipients, HDM no-meal recipients and non-participants, 2015–2017 Outcomes Evaluation Study



[a] Significantly different from HDM no meal recipients·
[b] Significantly different from HDM non-participants·
Pairwise differences between each 2 groups were tested using univariate t statistic, p set at <0·05.

Fig. 2 Percentage meeting average daily intake amounts of the 2010 Dietary Guidelines, at estimated amounts of calories needed for calorie balance, for men and women aged 66 years and over, 2015–2017 Outcomes Evaluation Study

Discussion

Results of this study show that the diet quality of HDM participants was higher on the days the meals were received compared with the days the meals were not received. This indicates that HDM participants may be more vulnerable when they do not receive a meal. The similar diet quality of meal recipients and HDM non-participants could arguably be the result of the matching process which did not use the homebound status as one of its matching criteria[12], and hence, the control group, although vulnerable, may be somewhat more able to access food than meal recipients and/or may have more assistance with shopping and cooking. This selection bias may have concealed possible differences in food access and diet quality. Nevertheless, these findings support the need to improve the diets of vulnerable older adults, both HDM participants and non-participants, given their low HEI scores.

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The diet quality of HDM participants when they received a meal was better in vegetables, SOFAAS, and seafood and plant proteins. Also, a larger proportion of HDM participants met the 2010-DGA recommended average daily intake for fruit, vegetables and dairy when meals were received. These findings support those of Frongillo and Wolfe[30], who, in a longitudinal study of HDM participants in NYC, found that compared with when meals were not received, meal recipients had better vegetable, dairy, energy and protein intake, and an increase in the number of servings from fats and sweets. Nevertheless, overall, the quality of the diet for HDM participants still requires improvement for several food groups/nutrients such as whole grains, fatty acid ratio, Na and SoFAAS.

Based on the 2010 DGA estimated amounts of calories needed for caloric balance in adults aged 66 years and over, less than 20 % of both HDM participants and non-participants consumed the daily average recommended amounts on a given day, for fruit, vegetables, dairy, protein foods and calories from solid fats. Less than one-quarter consumed the daily average recommended amounts on a given day for grains, approximately 50 % for calories from added sugars and about 40 % for Na. Previous studies have also shown that diets of older adults did not meet recommendations for several food groups/components and showed patterns similar to the current study[31–33]. Na content of meals continues to be an issue, as shown by this study and an earlier study that analysed meals delivered to older adults who are homebound[34]. It should be noted that meal content varies by local service provider sites, and, therefore, diet analysis at the different meal locations is advised to correct possibly high levels of saturated fat, Na and added sugar. These findings also suggest specific topics for nutrition counseling/education of older adults, a nutrition service that is also provided by the OAANSP. Nutrition education addressing healthy food choices may be warranted especially that most HDM participants have at least two chronic conditions.

There is an ongoing scientific debate regarding protein recommendations for older adults. It is argued that the current protein recommendations may not be sufficient to meet the needs of older adults and should be increased to guard against muscle wasting, falls and fractures in this population[35–38]. Our study shows that about 15 % of HDM participants and non-participants consumed the daily average recommended protein amounts on a given day. A larger proportion of HDM participants who received a meal consumed the daily average recommended protein amounts on a given day than HDM participants who did not receive a meal and HDM non-participants, although no significant differences existed. Further studies may be necessary to examine protein adequacy using the different recommendations proposed, and their association with relevant health outcomes.

Overall, our results suggest that analysis of HDM in the different local service provider locations and their modifications to better align with the dietary guidelines may be necessary. We found that even though the diet quality of HDM participants was higher on days when the meal was received, a number of dietary components and nutrients did not meet recommendations. Our findings are consistent with results from the nationally representative evaluation study in 1993–1995, which showed that the diets of HDM participants were nutrient dense, but of low calories, hence intake of some nutrients fell below the recommendations[39]. Other findings from the literature have also shown better diet quality of HDM participants, although these studies tended to include a small sample size and were not representative of the US population[30,40–42].

We found no difference between the diet quality of HDM participants when they received a meal, and their HDM non-participants, contrary to previous analyses of the Outcomes Evaluation Study[12]. In that study, HDM participants had a poorer diet quality compared with HDM non-participants. This discrepancy may be due to methodological differences which did not distinguish between participants who received a meal and those who did not receive a meal on the day of their 24-h recall(s)[12]. A possible explanation for the poorer diet quality of no-meal participants may be that they rely mostly on the HDM and do not necessarily replace that meal when it is not provided[10]. Results from the same dataset reported separately that 14 % of HDM participants skipped meals on days when they did not receive a HDM, and 92 % reported that the HDM represents more than one-third of their daily intake on the day when they did receive a meal[12]. It is not possible from this study to determine the reason why some participants did not receive a meal on the day of the 24-h recall(s). They may not be receiving HDM 5 d a week. In fact, nationwide, 34 % of HDM participants receive less than five meals/week[12]. This suggests that HDM participants who did not receive a meal on the day of the 24 h recall(s) may be at higher nutritional risk compared with HDM non-participants as seen from our study, and may signify that the programme is targeting individuals in most need, who may not consume nutritious meals if they were not participating in the HDM programme. Such findings are timely, considering the budgetary shortfalls and the gap in studies documenting the effectiveness of the programme[43]. Increasing programme funding to expand weekend home delivery and to provide more than one meal/d may improve the diet quality of participants. Only 12 % of all local service providers provided weekend meals in 2015, and only 4 and 15 % offered breakfast or dinner, respectively, in addition to lunch[5]. Gollub and colleagues have shown a positive impact on the nutritional intake of participants in five states who were provided with two meals a day: breakfast and lunch[44].

A strength of this study is that it is nationally representative of older adults on HDM programmes. It provides a unique opportunity to assess the diets of HDM participants and their HDM non-participants, and to examine diet

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quality of HDM participants on the day when a HDM is received. This is the first national study that we are aware of that evaluates the quality of other foods that HDM participants eat in addition to the meal. However, there are limitations as well. No information was collected to inform us of the reason why some participants did not receive a meal on the day(s) covered by the 24-h recall. This information may provide additional insights, which could be used to advocate for appropriate services and a potential increase in programme funding for expanded coverage especially to this targeted vulnerable population. Intervention trials may be needed to examine the nutritional status and health impact of expanding the programme to weekends and/or to include more than one meal/d. The results of this study also shed light on the vulnerability of the HDM non-participants. Exploring why this group of older adults do not participate in the OAANSP's Congregate Meal or HDM programmes may offer guidance on potential ways to reach them. Another limitation of this study is the fact that the analyses are based on self-reported 24-h recall dietary data, which have known limitations[45–47], including the reliance on accurate memory, and potential for bias stemming from under-reporting or over-reporting of certain foods. Nevertheless 24-h recalls can be representative of mean population intakes, such as those obtained using the population ratio method of HEI scoring. Another limitation of this study is that the data are an estimate of selected foods and nutrients consumed on a given day(s), rather than usual intakes which are used in providing dietary recommendations[48].

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980021004274

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