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Morris, MA orcid.org/0000-0002-9325-619X, Wilkins, EL, Galazoula, M et al. (2 more authors) (2020) Assessing diet in a university student population: A longitudinal food card transaction data approach. British Journal of Nutrition. ISSN 0007-1145

https://doi.org/10.1017/S0007114520000823

Title: Assessing diet in a university student population: A longitudinal food card transaction data approach

Running title: Novel data driven student dietary patterns

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Keywords

Student, Diet, Dietary patterns, Big data, Transactions

ABSTRACT

Starting university is an important time with respect to dietary changes. This study reports a novel approach to assessing student diet by utilising student-level food transaction data to explore dietary patterns.

First year students living in catered accommodation at the University of Leeds (UK) received pre-credited food cards for use in University catering facilities. Food card transaction data were obtained for semester 1, 2016, and linked with student age and gender. K-means cluster analysis was applied to the transaction data to identify clusters of food purchasing behaviours. Differences in demographic and behavioural characteristics across clusters were examined using Chi-squared tests. The semester was divided into three time periods to explore longitudinal changes in purchasing patterns.

Seven dietary clusters were identified: 'Vegetarian', 'Omnivores', 'Dieters', 'Dish of the Day', 'Grab-and-Go', 'Carb Lovers' and 'Snackers'. There were statistically significant differences in: gender ($p<0.001$) with women dominating the Vegetarian and Dieters; age ($p = 0.003$) with over 20's representing a high proportion of the Omnivores; and time of day of transactions ($p<0.001$) with Dieters and Snackers purchasing least at breakfast. Many students ($n = 474$, 60.4%) changed dietary cluster across the semester.

This study demonstrates that transactional data presents a feasible method for dietary assessment, collecting detailed dietary information over time and at scale, while eliminating participant burden and possible bias from self-selection, observation and attrition. It revealed that student diets are complex and that simplistic measures of diet,

focussing on narrow food groups in isolation, are unlikely to adequately capture dietary behaviours.

BACKGROUND

Starting university is an important time with respect to change in diet and wider lifestyle behaviours[1]. An unhealthy diet is a major risk factor for a variety of non-communicable diseases including; type 2 diabetes, cardiovascular disease and certain cancers [2].

Food choice is a complicated behaviour associated with numerous factors, including culture, parental preferences, nutrition knowledge, stress levels, and social class[3; 4; 5; 6]. Women often display healthier habits compared to men, especially when diet is taken into account[7]. However, nutrition related disorders or problems are also more common in women[8]. Diet quality has also been positively correlated with age[9].

Studies indicate that first year university students have a tendency towards an imbalanced diet irrespective of country of study[7] or culture[10]. In a large study of 738 students at the University of Kansas[11], for example, more than 69% of students failed to meet the recommended serving of 5 portions of fruit and vegetables per day, and a similar proportion (67%) did not meet the daily fibre recommendations (20g/day).

There are numerous studies that have investigated student diets across several countries. Most are of cross-sectional design and use self-report measures of diet including 24hr recalls or Food Frequency Questionnaires (FFQs) to track the diet of students[10; 12; 13; 14; 15; 16; 17]. Some also use proxy measures of diet, such as fruit and vegetable consumption [11; 18]. Sample sizes vary widely from convenience samples of a couple of hundred[19], through to tens of thousands in large cohort harmonisation or meta-analyses[18; 19]. Where studies contain a longitudinal element, most capture only broad details about student diets, such as the number of meals and snacks per day[19]

or a brief FFQ containing 22 items, aggregated into six food groups[16]. These measures of diet prohibit detailed analysis of dietary consumption patterns. As a result of self-selection to participate in the studies and the participant burden associated with survey completion, risks of selection and attrition biases are high. As with most measures of dietary assessment, reporting bias is also likely[20].

Transactional data from ready to eat food purchases could provide an objective measure of consumption and be easily monitored throughout the semester. Such data are not typically available. However, at the University of Leeds, students living in 'catered' halls of residence receive a 'Refresh' food card with credit for meals bought from the University refectory or coffee van. Data generated from these cards constitute a powerful tool to track student dietary behaviour.

The aims of this study are to: (i) utilise food purchase transactions from all students living in catered halls of residence at the University of Leeds during their first semester to identify common dietary patterns, (ii) examine differences in demographic and behavioural characteristics across dietary patterns; and (iii) investigate whether students maintain these patterns the semester.

METHODS

Study population

At the University of Leeds, first year students living in on-campus catered halls of residences are provided with 'Refresh' food cards, which contain credit to cover two meals per day Monday to Friday and brunch on weekends[21]. The cards can be used at the University refectory or coffee van and are included within students' accommodation fees. Unused credit from one day is not carried over to the next.

During semester one of the 2016/17 academic year, food cards were used by 835 first-year students. In October 2017 (one year after the initial data generation), all of these students were provided with information about this study, proposing to anonymously use their first year, first semester, retrospective food card information, and given the opportunity to opt out of the study. Four students opted out. Students who were younger than 18 (n = 24) or older than 24 years (n = 10) were also excluded from the study to prevent their potential identification due to low numbers. Two further students were excluded as they conducted fewer than one transaction per teaching week (1 and 2 transactions over the whole study period respectively), leaving a final sample of 795 students.

Ethics

This study was reviewed and approved by the University of Leeds Research Ethics Committee on the 1st September 2017, reference: LIDA 16-001.

Data sources

Food card data were extracted for semester one (12 September 2016 to 18 December 2016), covering the week before teachinwg began ('Fresher's Week') to the week after teaching concluded. The food card data provided information on the location, date and time of each transaction, the name, quantities and costs of specific items purchased within each transaction, and any promotional discounts applied (Supplement 1).

Daily food credit during the study period was £11.10, Mondays - Fridays and £6.30 on Saturdays and Sundays. The University refectory was open 8am to 7pm on week days and 10am to 2pm on weekends. It served a range of hot and cold foods, with a daily-changing menu including breakfast (available 8am-11am), hot and cold sandwiches,

salads and a wide variety of cooked meals (example menu at Supplement 2). Snacks, cakes and hot and cold drinks were also available. The coffee van additionally served hot and cold drinks, pastries, cakes, filled baguettes and fresh bread, and was open weekdays 8am to 5.50pm.

In order to explore demographic differences across dietary patterns, food card records were linked with University-held data on age and gender. Linkage was performed by an independent data services team and all data were anonymised prior to receipt by the research team. The anonymised data were screened prior to analyses, resulting in the exclusion of (i) 116 sales of an 'empty cup' and (ii) 30 transactions conducted at sites other than the refectory and coffee van (it was possible for students to 'top up' food cards to use in other food outlets on campus).

Food classification

There were 651 unique items purchased using the food cards. These items were manually categorised according to the Department of Environment, Food and Rural Affairs (DEFRA) eating out food and drink codes[22] (Supplement 3), in order to reduce the dimensions and optimise the clustering and its interpretation. The 651 items spanned 21 of the 22 DEFRA categories. There were no items in the DEFRA category 'Alcoholic drinks', as alcohol was not available for purchase using Refresh cards.

Analysis and visualisation

All data analysis and visualisation was carried out using R Studio version 1.1.453 and R 3.5.0, using the 'Riverplot'[23], 'Reshape2'[24], 'Plotrix'[25], 'Corrplot'[26], 'Chron'[27] and 'Ggplot2'[28] packages.

132 Development of dietary patterns

133 Similar studies seeking to identify dietary patterns have used a variety of techniques
134 such as principal component analysis, partial least squares regression, and clustering
135 algorithms[29; 30; 31]. K means clustering was used in our study, as this method is
136 designed to group samples (in this case students) into clusters that have similar
137 features (in this case purchasing behaviours). Furthermore, k means has been shown
138 to be more sensitive than other methods at detecting dietary patterns[30].

139 Prior to clustering, the data were transformed to mitigate skewness and standardised
140 to ensure equal weight for each variable. Specifically, for each student, the amounts
141 spent on each food category were expressed as a proportion of that student's total
142 spend over semester one and then arcsine transformed. These transformed values
143 were then standardised across each food type using z-scores. After transformation
144 and standardisation, the k means clustering algorithm was applied using a range of
145 cluster numbers (1 to 20). The appropriate number of clusters was selected using a
146 scree plot to identify the inflection point and through consideration of the numbers of
147 students per cluster, to ensure approximately equal cluster sizes.

148 Examining demographic and behavioural characteristics by cluster

149 Chi-squared tests were used to explore differences in the distribution across dietary
150 clusters of (i) student age (18, 19 or 20+ years), (ii) gender (male or female) and (iii)
151 the time of day at which purchases were made.

152 **Diet change over time**

153 In order to observe diet change over time, the sales for each student were further
154 divided into three time periods. While the available data spanned 14 weeks, week 14

was a non-teaching week with a very low number of transactions (n = 10) and was therefore excluded from this aspect of the analyses. Accordingly the three time periods spanned weeks 1-5, 6-9 and 10-13 respectively.

For the purchases made by each student in each of these three time periods, their distances to each of the original cluster centres were calculated, using squared Euclidean distance, and each student was assigned to the cluster with the minimum distance. Cross tabulations of the data were produced in order to follow the movement of students between clusters, with transitions also visualised using a Riverplot[23].

RESULTS

Study sample

The final sample included 795 students, who collectively conducted 107 723 transactions, spending £457 369 on 303 714 items over the semester (each transaction could include multiple items e.g. sandwich and drink). Student-level demographic and transactional characteristics are reported in Table 1. The sample was predominantly aged 18 or 19, with more females than males.

Proportional spending per food group remained largely stable over the term (Supplement 4), with the exception of week 1 (Fresher's Week) and week 14 (the week after teaching concluded). There was also a notable increase in spending on 'other food products' in week 13 (the final week of teaching). Across the 21 DEFRA food groups, students spent the most money on 'meat & meat products' (£74 785), 'soft drinks' (£68 054) and 'sandwiches' (£46 301) and the least money on 'yoghurts and fromage frais' (£2 282), 'breakfast cereals' (£3 002) and 'soups' (£4 083).

Dietary clusters

Examination of the scree plot (Supplement 5) identified seven dietary clusters, summarised in Table 2 and illustrated using radial plots at Supplement 6. The clusters were ranked for healthfulness based on food variety and the prominence of fruits, vegetables and salads within each pattern (Supplement 7). This provided a crude indication of the healthfulness of each cluster, used only to order clusters in tables and figures. It should not be taken as a holistic or accurate description of diet quality as there was insufficient information to calculate validated diet quality scores.

Demographic and behavioural characteristics of clusters

Figure 1 shows demographic and behavioural characteristics of the clusters. Chi-squared tests revealed statistically significant differences in: gender ($p<0.001$), with women dominating the Vegetarian and Dieters clusters; age ($p = 0.003$) with over 20's representing a high proportion of the Omnivore cluster; and time of transaction ($p<0.001$) with Dieters and Snackers purchasing least between 0800 and 1100h. (Panels A-C respectively).

Diet change through time

There were 785 students with transactions in all time periods 1-3. Table 3 cross-tabulates students who remained in the same cluster (numbers in bold) or moved clusters between time periods. Figure 2 displays these transitions using a Riverplot. A notable proportion of students (n = 474, 60.4%) changed dietary cluster across the semester (calculated using the sum of movements from time periods 1-2 and periods 2-3). The Grab-and-Go and Dieters groups were the most transitory. For example, 52.5% of students in the Dieters cluster at period 1 transitioned to another cluster at

period 2, and 50.4% of the students in this cluster at period 2 were new students who had transitioned from another cluster in period 1. There were, however, no dominant patterns of movement between specific clusters. The highest number of students moving from one particular cluster to another was 35, which occurred from ‘Dieters’ to ‘Snackers’ (periods 1-2: 19 transitions; periods 2-3: 16 transitions). There is evidence that some students moved back to the same cluster which is highlighted when comparing time period 1 to time period 3 where only 25 students are observed to have transitioned from ‘Dieters’ to ‘Snackers’.

When change in pattern is stratified by gender, different patterns of change are observed, further highlighting the difference in behaviour between females and males. Please refer to supplement 8 for these findings.

DISCUSSION

Key findings

Our study employed a novel dataset to examine student food purchasing behaviours during an important life-stage: the move to university. Using records of food purchases, obtained via student food cards, this study found seven distinct dietary patterns. Use of student food card data allowed detailed, objective measurement of food purchases over a sustained period, overcoming limitations and biases inherent in traditional research. Our findings provide a greater understanding of the dietary practices of students during a key transitionary period, and help to identify potential groups of students to target in health-improvement interventions or in future research into underlying drivers for lifestyle behaviours.

Overall dietary patterns

Many of the dietary patterns identified in this study comprised a mixture of 'healthy' and 'unhealthy' foods. For example, while the 'Omnivorous' group had particularly high purchases of desserts, they also consumed a wide variety of other foods, including high purchases of cereals, fish, and vegetables which feature prominently in UK dietary guidelines[32]. This illustrates that student diets are not always either wholly 'healthy' or 'unhealthy' and that measurement of a small number of dietary components, as is common in the literature[11; 18], may be inadequate to capture the dietary practices of many students.

The above notwithstanding, it was possible to identify patterns of food purchasing that were comparatively less healthy. These included the Snackers, Carb Lovers and Grab-and-Go groups, which were all associated with limited food variety, low purchases of fruits, vegetables, and salads, and high purchases nutrient poor and calorie dense foods. These groups collectively comprise nearly 40% of students, and present a potential target group for dietary interventions and further investigation.

One limitation of using data-driven techniques such as cluster analysis is that comparison with other literature is challenging. Nevertheless, two previous UK studies investigating the diets of university students[33; 34] and one investigating the diets of Irish adolescents[30] have all observed dietary patterns similar to our 'Snackers' cluster, suggesting this may be a behaviour profile that transcends student/adolescent groups. Sprake et al. [33] also identified clusters similar to our Vegetarian and Dish of the Day clusters among 1,448 UK university students, suggesting these may also be somewhat pervasive patterns. A scoping review of food choice amongst young adults in the US identified similar general patterns, highlighting that snacking, rather than

consuming 3 meals, is a popular behaviour in this age group, as observed in our Snackers and Grab-and-go patterns. Additionally they observe that 'healthy' food items can be a driver of food choice in some, which we can see in the Vegetarian and Dieters clusters [35].

Behavioural and demographic variations

Our study cohort contained more females (53.7%) than males. This aligns with University statistics indicating a higher percentage of female undergraduate admissions in 2016 (61.6%) [36]. However, given that the difference between the proportion of males and females in our cohort is smaller than that of Leeds undergraduates more widely, results suggest that a higher proportion of males chose catered halls for their accommodation, although further investigation into the methods of assignment of accommodation would be required to confirm this.

Our findings broadly support past literature suggesting that dietary patterns differ with gender. Previous studies have found females exhibit healthier dietary behaviours[7], but are also more prone to nutrition related disorders[8]. We found similarly complex relationships between gender and diet. For example, while females dominated the Vegetarian pattern (arguably the healthiest), there was also a high proportion of females in the Snackers pattern (arguably the least healthy), suggesting that females may tend towards dietary extremes. This is also supported by the dominance of females in the Dieters pattern, which was characterised by consumption of a very limited range of foods (predominantly soups).

Past research has found age to be positively correlated with diet quality[9]. Our study included students of a relatively narrow age range (18-24 years), yet still found

differences in student ages across clusters. There was a dominance of older students in the Omnivores cluster and younger students in the Snackers cluster which partially supports the hypothesis that increasing age is associated with a healthier diet. However, the relationship was again complex. For example, there was a comparatively low proportion of older students in the 'Vegetarian' cluster which had the highest rank of healthfulness.

We investigated whether clusters differed in the time of day at which purchases were made. The Snackers and Dieters clusters tended to buy food items later in the day. Given that the Snackers were characterised by high spending on packaged foods, it is possible that these students are using up unspent credit for later consumption. This is in line with feedback from the catering marketing team, who felt purchases of snack food increased near to closing time. In contrast it is somewhat surprising that the Dieters group also made a large amount of evening transactions, given that the foods purchased by this group tended to be 'light' meals typically associated with lunch (e.g. soups).

Comparatively few purchases were conducted between 8am and 11am. Skipping breakfast has been consistently associated with increased BMI and obesity risk among children and adolescents[37]. Our findings may therefore help explain the weight gain commonly observed among new university students [38; 39]. However, we cannot rule out that students consumed breakfast at their accommodation or elsewhere, particularly as breakfast is often cheap and easy to prepare, requiring limited or no cooking skills and facilities, and therefore students may save their food card credit for more costly/time-consuming meals.

Change over time

Several studies have assessed dietary changes following the transition to university, with contradictory findings. For example, despite observing weight gain, Butler et al. [40] found that energy intake (assessed via FFQ) decreased among female freshmen students over the first 5 months of university and Racette et al. [41] observed fried food intake decreased (again using questionnaires). These discrepancies are likely due to the inherent inaccuracies of traditional dietary assessment. Our study, which used objective data from food purchase cards, found overall spending on DEFRA food categories was largely stable (excluding weeks 1 and 14, which were non-teaching weeks with fewer students present on campus). A notable exception to this rule was an increased spending on 'other food products' in the final week of term; attributable to purchases of Christmas dinners, which were only available in this week. Wansink et al. [42] found that unhealthy snack choices in a college cafeteria increased by 8% in the last two weeks of term, and that this pattern reoccurred across subsequent terms. The authors hypothesised that assignment-related stress may be driving hedonic food purchases; however, we found no evidence of this in our data.

While spending on foods was stable when considering the sample as a whole, we found a high proportion of students moved between dietary clusters, suggesting dietary patterns do change at the individual level. Starting university represents a marked increase in dietary independence for many students[1], and the fluidity of dietary patterns across the first semester may represent an exploratory phase, whereby students seek to establish new dietary habits. This period may therefore represent a prime opportunity for dietary intervention. Further research is needed over

multiple semesters and years of university to establish longer-term dynamics of dietary behaviours.

Interestingly, the largest transition between clusters was from Dieters to Snackers. The Dieters cluster was also one of the most transitory clusters, suggesting this group of students may be following a limited variety, low-calorie and ultimately unsustainable diet, and then reverting to other, often less healthy, dietary behaviours. This pattern of 'yo-yo' dieting has been associated with weight cycling and even weight gain[43].

Strengths and limitations

This study has several strengths. In contrast to traditional dietary studies, this study used objective transaction data at the individual level over a sustained period of time (14 weeks) to assess diet. Students did not know about the study at the time of data collection, eliminating observer bias. Additionally, while students had the opportunity to opt-out, they did not actively need to sign up and commit their time to the research, limiting self-selection and attrition biases.

This study also has limitations. The food card data represents foods purchased, which we cannot be certain were consumed, although consumption was likely given these were ready to eat food purchases. The transactions did not contain information on all foods consumed in a day, and students likely consumed at least one additional meal elsewhere. The data also did not contain information on alcohol consumption, which is often a large part of student life in the UK[19]. These problems are exacerbated in that students did not typically spend their full credit every day; suggesting students may consume a considerable portion of meals outside of the University catering facilities. That said, this study does present an improvement over previous literature

by objectively capturing a broader selection of foods purchased/consumed, over a longer period compared with traditional dietary research.

Food purchases were constrained by what was available, which was a broad but not limitless selection (Supplement 2). Having credits for catered food may also have influenced food choices compared to what would be eaten if meals were self-catered using students' own budgets. For example, students may be more likely to consume cereal or toast for breakfast rather than a cooked breakfast due to speed and cost considerations. The findings of this study should therefore be generalised with caution.

We did not know the break-down of students across the three halls of residences on campus, so were unable to account for differences across halls. That said, all halls were very close to the University refectory and coffee van (all within 150-300m) and therefore all students had similar access to the catered facilities.

Detailed information regarding the nutritional composition of purchased foods was unavailable. However, we did rank clusters based on the variety of foods purchased and the dominance of fruits and vegetables in the pattern, providing an approximate indicator of healthfulness which was useful for ordering clusters within tables and figures and spotting broad trends. Clustering was performed based on the amount of money spent, which is not necessarily indicative of amounts of foods consumed (in terms of calories or grams). However clustering on price allowed us to account for promotions, and to standardise student budgets for a fairer comparison.

In future research, it would be advantageous to link information on body mass index for these students, using student medical practice records. However, this would be

challenging from an ethical and governance perspective without informed consent and could reduce sample size and introduce bias.

Conclusion

To our knowledge, this is the first time transactional student card data have been used to research health behaviours. This study demonstrates that data from food cards can be used as an alternative to traditional dietary assessment methods, which suffer from numerous limitations, as noted above. That said, a number of challenges were encountered in using these data. Firstly, ethical approval was challenging to obtain. While students agreed upon enrolment to the University that their data could be used in future research, they did not explicitly consent to participate in this study, and ethical approval was initially declined. Following appeal of the ethics decision, and assurance that no student would be identified, the ethics committee agreed an 'opt-out' as a compromise. Use of large consumer data in this way is novel, and some ethics committees may not yet be fully prepared to deal with it. A recent Delphi survey of experts in the field of obesity and big data called for ethical processes to be reviewed in this regard[44]. Linking the food card with University records on age and gender was challenging. Student identifiers within the University administrative systems were not compatible, and linkage had to be done via student emails, using an independent data services team in a secure ISO27001 accredited infrastructure, so that researchers were never exposed to student identifiers. Finally, as the food card data were managed by a third party, there was a fee of £750 + Value Added Tax (VAT) for the data extraction.

Insight generated by this research is now being used by the catering marketing team to help inform their health promotions to this group of students and others. There is potential for further health promotion beyond the University setting.

Despite the challenges, our novel data approach was shown to be achievable within typical budget and time constraints. Future research should investigate other sources of transactional data, such as supermarket loyalty cards, to allow access to different populations and increased scale.

SUPPLEMENTARY INFORMATION

Supplementary information is available online.

Declarations

- **Ethics approval and consent to participate**

This study was reviewed and approved by the University of Leeds Research Ethics Committee on the 1st September 2017, reference: LIDA 16-001.

Explicit consent was not required as data are anonymous. Students were given the opportunity to opt-out and have their data removed before the data were anonymised and supplied to the research team.

- **Consent for publication**

Not applicable.

- **Availability of data and material**

The data that support the findings of this study are available from a third party company but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available.

- **Competing interests**

MAM is a shareholder in Dietary Assessment Ltd.

- **Funding**

This work was funded via Economic and Social Research Council grant number ES/N00941X/1 as part of the ESRC Strategic Network for Obesity.

Stephen Clark and Mark Birkin are funded by the Economic and Social Research Council grant number ES/S007164/1, the Consumer Data Research Centre.

- **Authors' contributions**

MAM contributed to conception of the paper, acquiring the funding, designed the research, acquired data, obtained ethical approval, line managed EW, MG and SDC and contributed to each draft of the manuscript.

EW and MG carried out substantial data cleaning and analysis and drafting of the manuscript, with equal contribution.

SDC co-supervised MG, provided analytical support during the analysis and contributed to drafts of the paper.

MB contributed to conception of the paper, acquiring the funding and commented on drafts of the manuscript.

- **Conflict of Interest:**

MAM is a shareholder in Dietary Assessment Ltd; co-authors declare no competing interests.

- **Acknowledgements**

Thank you to all the students whose data were used in this research.

The authors would like to thank all of the ESRC Strategic Network for Obesity investigators[a] and members[b] for their participation in network meetings and discussion which contributed to the development of this paper.

Particular thanks to Adam Keeley (LIDA Data Services team), Thomas Exeter (The Edge), and Shelley Fox (Refresh) for their support and advice with data acquisition, processing and understanding.

[a] - www.cdrc.ac.uk/research/obesity/investigators/

[b] - www.cdrc.ac.uk/research/obesity/network-members/

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TABLES

Table 1. Demographic and transactional characteristics of our sample

Gender	**n (%)**
Male	337 (42.4%)
Female	427 (53.7%)
Unknown	31 (3.9%)
Age	**n (%)**
18	392 (49.3%)
19	221 (27.8%)
20-24	153 (19.2%)
Unknown	29 (3.6%)
Transactional Information	**Mean (SD)**
Transactions per student over period (N)	135.5 (40.9)
Transactions per student per week (N)	10.9 (4.5)
Money spent per student over period (£)	575.26 (113.92)
Money spent per student per week (£)	46.43 (14.66)

n: number of students; N: number of transactions; SD: standard deviation.

558 **Table 2. Summary of dietary patterns, derived from data in the radial plots provided at**
559 **supplement 6.**

Cluster name	Rank*	Typical purchasing pattern	Cluster size n (%)
Vegetarian	1	High purchases: Yoghurt & fromage frais; breakfast cereals; salads. Low purchases: Meat & meat products; other food products; cheese and egg dishes or pizza.	113 (14.2%)
Omnivores	2	High purchases: Ice cream, desserts & cakes; breakfast cereals; fish & fish products. Low purchases: Confectionary; soft drinks including milk; sandwiches.	117 (14.7%)
Dieters	3	High purchases: Soups; rice, pasta or noodles; salads. Low purchases: Breakfast cereal; yoghurt & fromage frais; ice cream, desserts & cakes.	122 (15.3%)
Dish of the Day	4	High purchases: Meat & meat products; Indian, Chinese or Thai food; other food products. Low purchases: Soups, biscuits, yoghurt & fromage frais.	126 (15.8%)

Grab-and-Go	5	High purchases: Sandwiches; crisps, nuts and snacks; cheese and egg dishes or pizza. Low purchases: Soups; breakfast cereals; Indian, Chinese or Thai food.	110 (13.8%)
Carb Lovers	6	High purchases: Bread, cheese and egg dishes or pizza, ice cream, desserts & cakes. Low purchases: Salads, soups, yoghurt & fromage frais.	77 (9.7%)
Snackers	7	High purchases: Confectionary; biscuits; crisps, nuts and snacks. Low purchases: Yoghurt & fromage frais; salads; breakfast cereal	130 (16.4%)

560 n: number of students. *Rank: 1 = most healthy; 7 = least healthy (determined
561 according to the prominence of fruits and vegetables and the variety of foods
562 purchased).

563 **Table 3. Cross-tabulation of numbers of students within dietary clusters during time periods 1-3.**

		Vegetarian	Omnivores	Dieters	Dish of the Day	Grab-and-Go	Carb Lovers	Snackers	% Moving Out
		Time Period 2							
Time Period 1	Vegetarian	**69**	13	9	0	2	2	3	29.6%
	Omnivores	12	**72**	12	11	3	4	3	38.5%
	Dieters	11	11	**57**	4	11	7	19	52.5%
	Dish of the Day	0	11	5	**79**	11	8	9	35.8%
	Grab and Go	9	2	15	10	**56**	15	12	52.9%
	Carb Lovers	3	8	8	12	8	**43**	8	52.2%
	Snackers	3	6	9	14	9	9	**68**	42.4%
	% Moving In	35.5%	41.5%	50.4%	39.2%	44.0%	51.1%	44.3%	
		Time Period 3							
Time Period 1	Vegetarian	**57**	9	18	1	4	4	5	41.8%
	Omnivores	13	**66**	12	11	4	7	4	43.6%
	Dieters	14	6	**52**	11	7	5	25	56.7%
	Dish of the Day	1	9	10	**70**	13	11	9	43.1%
	Grab and Go	7	4	13	12	**51**	17	15	57.1%
	Carb Lovers	4	11	7	7	8	**41**	12	54.4%
	Snackers	4	9	8	15	15	10	**57**	51.7%
	% Moving In	43.0%	42.1%	56.7%	44.9%	50.0%	56.8%	55.1%	
		Time Period 3							
Time Period 2	Vegetarian	**67**	6	21	1	5	3	4	37.4%
	Omnivores	12	**78**	5	14	3	6	5	36.6%
	Dieters	15	4	**60**	8	6	6	16	47.8%
	Dish of the Day	1	12	7	**85**	11	9	5	34.6%
	Grab-and-Go	4	3	5	7	**54**	13	14	46.0%
	Carb Lovers	0	4	9	5	7	**53**	10	39.8%
	Snackers	1	7	13	7	16	5	**73**	40.2%
	% Moving In	33.0%	31.6%	50.0%	33.1%	47.1%	44.2%	42.5%	

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FIGURE CAPTIONS

Figure 1. Distribution of gender, age, and time of transaction by cluster (Panels A-C respectively).

Labels on bars show numbers of students for Panels A and B, and numbers of transactions for Panel C. Panels A and B exclude students with unknown gender and age respectively.

Figure 2. Riverplot showing the flow of students between dietary clusters at time periods 1-3