

Article

Factors Influencing Consumption of Animal-Based Dairy and Plant-Based Milk Alternatives in Australia

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Abstract: In the transition to more environmentally sustainable food systems, the production and consumption of resource-intensive animal-based dairy foods (ABD) remains a talking point. Given the power of consumer choice in transforming food systems, understanding consumer priorities surrounding ABD consumption and their plant-based counterparts is fundamental. Using data from 3271 unique survey respondents, the objectives of this study were to examine the consumption frequencies of ABD and plant-based milk (PBM) in Australia over time (2019–2022) and determine the psychosocial and sociodemographic factors associated with distinct consumer segments. Multi-variate analysis identified sociodemographic and food choice factors associated with three consumer segments: ‘exclusive PBM consumers’, ‘exclusive ABD consumers’, and ‘mixed consumers’ (consumers of both product types). Despite the growing availability of plant-based milk alternatives, exclusive PBM consumption remains relatively uncommon compared to mixed plant and animal dairy consumption. ‘Exclusive ABD consumers’ had a higher probability of being older and less likely to prioritise health and nutrition than ‘mixed consumers’. ‘Exclusive PBM consumers’ were more likely to prioritise food tolerance and restrictions and less likely to prioritise product taste than ‘exclusive ABD consumers’. We report sociodemographic and motivational factors influencing animal-based dairy and plant-based milk choices. The outcomes are of interest to sustainable food systems development stakeholders, with potential applications in the public health and commercial food promotion sectors.

Keywords: sustainable food consumption; food choice; dairy alternatives; consumer priorities



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1. Introduction

The global food system currently operates beyond environmental health boundaries [1]. One approach to improve the environmental sustainability of food systems is to reduce the production and consumption of resource-intensive foods, such as animal-based dairy products (ABD). Plant-based dairy alternatives, such as plant-based milks (PBMs), can offer a less resource-intensive alternative to ABD [2]. Acknowledging there is variation by region, compared to animal-derived products, PBMs are generally derived from more resource-efficient crops, such as grains, legumes, nuts, and seeds, posing an opportunity for reduced resource depletion through production [2]. Importantly, consumer choice (demand-side) is a crucial driver in the transition to more environmentally sustainable food production, especially given the challenges of decarbonizing the livestock sector [2,3].

The Australian context provides an interesting setting within which to study ABD and PBM consumption. The Australian dairy industry is well established yet faces calls to meet national and international sustainable development targets due to its small but significant contribution to national greenhouse gas emissions [4]. Indeed, dairy has long been a staple food group in Australian diets. Consumption data from 2011 to 2012 report 69% of Australians consumed 139 g of dairy milk on the day of the survey, compared to 3.7% consuming 7.8 g of dairy milk substitutes [5]. Dairy and dairy alternative intake is recommended in the Australian Dietary Guidelines, specifically between 1.5 and 4 servings of milk, yoghurt, cheese, and/or alternatives per day, depending on gender and age group [6], further cementing ABD in the Australian diet.

Despite ABD dominating the domestic Australian market, recent estimates suggest approximately 40% of Australian households purchase PBM beverages alongside animal-based dairy milk [7]. Further, the demand for PBM products has grown in recent years, while ABD sales are stagnating. Sales of PBM in Australia have increased rapidly since 2018, with 'dairy milk substitutes' purchase data increasing from 13.1 g per day in 2018 to 17.1 g per day in 2021; this represents an increase of 30.1% grams sold per day compared to −2.2% grams per day for animal-based dairy milk [8].

As the PBM market continues to grow in Australia and abroad and the call for more sustainable animal food production intensifies, there is a need to better understand changes in the consumption patterns of animal- and plant-based dairy products and the factors associated with different consumer types. Using an Australian sample, this study presents consumption frequency insights and demographic and psychosocial factors associated with consumers of dairy and dairy-alternative products.

Consumer motivations contributing to increasing plant-based milk consumption are poorly understood. Proposed motivations include perceived health benefits of PBM, as well as a growing cohort of consumers suffering lactose intolerance and milk protein allergies [9]. With global dairy milk production contributing 3% of global greenhouse gas emissions, environmental motivations to consume less animal-based dairy milk are also suggested and are likely reflected by increasingly common diet patterns such as veganism [10,11]. However, these motivators have rarely been investigated from a consumer behaviour standpoint and rarely in an Australian context.

The limited available literature, based mainly on online surveys and interviews conducted in the United States, suggest a range of factors associated with exclusive PBM consumption or mixed plant- and animal-based dairy consumption, relative to exclusive animal-based dairy consumption. These factors include beliefs about animal welfare [12,13], environmental impact/sustainability [14,15], and (lower perception of) dairy milk as a staple item [12]; vegetarian/vegan dietary preferences [16]; political orientation [16]; and some sociodemographic characteristics including age [17], gender [18], and presence of children in the household [16].

In the Australian context, consumer behaviour research is limited to two studies conducted over two decades ago [19,20]. Using random but relatively small samples of shoppers from a single location, these studies presented mixed findings regarding associations between cultural background and the consumption of soy milk. Thus, Australian consumer data on PBM consumption habits and associated factors are limited to relatively small and outdated studies, conducted when the PBM market comprised primarily soy milk [21].

This study contributes to the limited extant literature describing differences between animal-based and plant-based dairy consumer groups. The specific objectives of this study are (1) to examine consumption frequencies of plant-based milk and animal-based dairy in Australia during a market growth period (from 2019 to 2022) and (2) determine the psychosocial and sociodemographic factors associated with distinct consumer segments based on patterns of dairy and plant-based milk consumption, that is, exclusive plant-based milk consumers (PBM), exclusive animal-based dairy consumers (ABD), and mixed consumers (consuming both PBM and ABD). The findings have implications for the marketing and

promotion of ABD and PBM, as well as informing behaviour change interventions towards more environmentally sustainable dietary choices.

2. Materials and Methods

2.1. Survey Instrument

This study utilised data collected using the Food Insights Questionnaire (FoodIQ), an online survey of Australian shoppers established by the University of Adelaide's Centre for Global Food and Resources in 2018. The survey instrument is designed to respond to current food issues and trends, providing insight into Australian consumer food choice behaviour. Previous applications of the FoodIQ questionnaire include examining dietary patterns, motivations, and intentions of the increasingly common 'flexitarian' cohort (meat reducers) and to better understand variation in consumer preferences for alternative protein sources [22,23].

Reputable online panel provider, DynataTM are engaged to recruit survey samples at 6-month or 12-month timepoints. Each timepoint sample consists of over 1000 participants, with data collection commencing in 2018. Recruited samples represent the Australian population on factors including gender, age, education level, residence in Australia's states/territories and metropolitan areas, having children in the household, cultural background, and household income. DynataTM also perform data quality checks to reduce erroneous responses in the final dataset.

Our study analysed FoodIQ data collected between June and August each year from 2019 to 2022 (four timepoints). This period was chosen as a time of reported increased dairy milk substitute purchasing in Australia [8]. Eligible respondents were aged ≥ 18 years and solely or jointly responsible for household food shopping. Ethics approval was provided by the University of Adelaide Human Research Ethics Committee (H-2018-173).

Four cohorts were recruited between 2019 and 2022, with a total of 4196 responses obtained. Some responses ($n = 1645$) were submitted by recurring survey respondents who returned to participate in the same survey at multiple timepoints. Of the 4196 responses received, 3271 were submitted by 'unique' respondents. Each cohort was nationally representative with respect to gender, age, university education, and residential area (see Table 1).

Survey items assessed consumption frequency, motivations, behaviours, and perceptions regarding food-related topics. Survey items used for the present analysis include

- consumption frequency during the previous 12 months for dairy products (milk, cheese, and yoghurt) and plant-based milk products (e.g., soy, almond, oat, rice, and macadamia milk);
- dietary pattern (omnivore, semi-vegetarian/flexitarian, full-time vegetarian, and vegan);
- relative importance placed on 15 different food choice factors when grocery shopping, measured using a point allocation task;
- sociodemographic and household characteristics.

2.2. Statistical Analysis

Descriptive statistics were conducted in SPSS (version 29.0) and multivariate analyses in Stata (version 17). Chi-squared tests of independence were used to compare categorical variables, with Bonferroni-adjusted p -values used for multiple comparisons. ANOVA tests were used for comparison of means, with Welch's F statistic used for variables with heterogenous variance across dairy consumption groups and post hoc Tamhane's T_2 tests used for multiple comparisons.

To address objective one (to examine the consumption frequency of plant-based milk and animal-based dairy in Australia over time) all 4196 responses collected from 2019 to 2022 were analysed. This therefore included 'recurring' respondents, individuals who completed the same survey at multiple timepoints ($n = 1645$). Mean consumption frequencies were derived from a categorical variable with 10 response options ranging

from 0 = never consume to 9 = consume every day. Tables 1 and 2 present analysis of this sample.

To address objective two (determine the psychosocial and sociodemographic factors associated with distinct consumer segments based on patterns of dairy and plant-based milk consumption), consumer groups were defined by the results of the ‘consumption frequency’ survey item as follows:

- Exclusive ABD consumers: respondents who ‘never’ consumed PBM in the past 12 months, but consumed ABD at any frequency in the same period;
- Mixed consumers: respondents who consumed both PBM and ABD at any frequency in the past 12 months;
- Exclusive PBM consumers: respondents who ‘never’ consumed ABD in the past 12 months, but consumed PBM at any frequency in the same period.

Analysis for objective 2 followed a smaller set of respondents than objective one, with respondents excluded based on three criteria: (1) it was not the respondent’s most recent submission (applies to recurring respondents only, with their most recent submission retained for analysis) ($n = 1645$); (2) respondents had consumed neither PBM nor ABD in the past 12 months ($n = 56$); and (3) data were collected in 2019, as the ‘Food Choice Factor’ item was not included in this year’s survey instrument ($n = 740$). Therefore, the multivariate analysis was based on a sample of 2475 unique survey respondents which was found to be nationally representative. Tables 3 and 4 present analysis of this sample.

A multinomial logit regression model (MNL) was used to identify factors associated with dairy consumer group membership. The most appropriate MNL model for determining the predictive value of participants’ characteristics on group membership was identified based on minimum Bayesian information criterion (BIC) value, variance inflation factor values (maximum 2.89), and researcher judgement. For our model, non-parametric Spearman’s tests returned a maximum correlation coefficient of 0.517. Table 4 presents the marginal effects for each variable on the three consumption groups. Independent variables in the model included those previously found to be associated with consumption of ABD and/or PBM, including beliefs about animal welfare [12,13]; environmental impact [14,15]; vegetarian/vegan dietary preferences [16]; and sociodemographic characteristics including age [17] and gender [18] and presence of children in the household [16]. Remaining variables in the model were included due to their likely relevance to this study, given their relevance to the similar topic of alternative protein consumption; these factors included a panel of ‘individual’ food choice factors, describing personal food preferences such as taste, appearance, and price, as well as further demographic factors such as household income, residence in a metropolitan area, living with a partner, and education level. The marginal effects are interpreted relative to the omitted reference category for each variable.

3. Results

3.1. Participant Characteristics in Each Cohort

Characteristics of participants in each cohort are presented in Table 1. Most cohorts were nationally representative (within 5% of national data) with respect to gender, age, education, and residential area. Statistically significant differences were found between the 2022 cohort and the others with a larger share of respondents aged ≥ 55 years and a smaller share aged 18–24 years in 2022. The 2022 cohort also had a higher share of females compared to the 2021 cohort, and the 2020 cohort had a higher share of metropolitan respondents compared to the two later cohorts. Notably, cohorts did not differ significantly with respect to the proportion of respondents with an Australian (77%) or Asian (7%) cultural background or with children (<18 years) in the household (33%).

Table 1. Participant sociodemographic characteristics per yearly survey cohort.

Characteristic		Survey Cohort (%)				Total (n = 4196)	Australian Population *
		June 2019 (n = 1019)	June–July 2020 (n = 1125)	June–July 2021 (n = 1001)	July–August 2022 (n = 1051)		
Gender	Male	47.9 ^{ab}	47.2 ^{ab}	49.0 ^b	42.2 ^a	46.5	49.3
	Female	52.0 ^{ab}	52.6 ^{ab}	50.6 ^b	57.8 ^a	53.3	50.7
	Unspecified/Intersex	0.1 ^a	0.2 ^a	0.4 ^a	0.0 ^a	0.2	-
Age (y)	18–24	14.1 ^a	11.4 ^a	12.5 ^a	4.1 ^b	10.5	6.2 [†]
	25–34	15.3 ^a	18.6 ^{ab}	20.5 ^b	14.9 ^a	17.3	14.3
	35–44	18.9 ^a	19.0 ^a	18.4 ^a	19.1 ^a	18.9	13.7
	45–54	18.1 ^a	18.8 ^a	15.6 ^a	17.4 ^a	17.5	12.7
	55–64	15.8 ^a	15.5 ^a	15.6 ^a	21.3 ^b	17.0	11.9
	65+	17.8 ^a	16.8 ^a	17.5 ^a	23.1 ^b	18.8	17.2
University degree		38.3 ^{ab}	46.2 ^c	40.9 ^{bc}	34.9 ^a	40.2	36.8 [‡]
Metropolitan area		71.1 ^{ab}	73.5 ^b	65.8 ^a	66.6 ^a	69.4	66.9
Children < 18 y living in household		34.1 ^a	33.6 ^a	33.5 ^a	30.2 ^a	32.8	-
Cultural background	Australian	77.8 ^a	75.6 ^a	76.3 ^a	76.5 ^a	76.5	-
	Asian [§]	6.9 ^a	8.4 ^a	6.9 ^a	7.0 ^a	7.3	-
Household income (pre-tax)							
Quintile one (≤AUD 35,000)		22.6 ^{ab}	18.0 ^b	26.1 ^{ac}	28.8 ^c	23.8	-
Quintile two (AUD 35,001–AUD 65,000)		20.2 ^a	19.9 ^a	21.8 ^a	23.6 ^a	21.4	-
Quintile three (AUD 65,001–AUD 105,000)		18.5 ^a	24.2 ^b	24.3 ^b	23.7 ^b	22.7	-
Quintile four (AUD 105,001–AUD 165,000)		23.1 ^a	20.1 ^{ab}	15.9 ^b	16.0 ^b	18.8	-
Quintile five (>AUD 165,000)		15.6 ^{ab}	17.8 ^b	12.0 ^a	7.9 ^c	13.4	-

^{abc} Percentage values in a row with unlike superscript letters were significantly different ($p < 0.05$) based on results of Chi-squared test of independence. * Australian population data are from the Australian 2021 Census [24]. [†] The 18–24 age bracket survey data are compared to the Census's 20–24 age bracket. [‡] The University degree survey data are compared to the Census's 20–64 age bracket. The next available age bracket is 15–74 years with a 32.1% university degree award rate [25]. [§] Includes Mainland South-East Asian, Maritime South-East Asian, Chinese Asian and Other North-East Asian.

3.2. Consumption Frequency Over Time

Consumption frequencies of ABD and PBM are compared from 2019 to 2022 (Table 2). Overall, 96% of respondents reported consuming any ABD in the past 12 months (less than weekly, weekly, or everyday), compared to 39% for PBM. On average, ABD was consumed more frequently than PBM, with an average consumption score of 6.9 (which equates to four days per week), compared to a score of 1.9 (less than once per month) for PBM. Most participants consumed ABD daily (47%) or at least once per week (46%). In contrast, only 7.9% consumed PBM daily and 21% at least once per week (1–6 days).

Table 2. Self-reported consumption of animal-based dairy and plant-based milk collected annually from representative Australian samples.

		Survey Cohort				Total (n = 4196)	
		June 2019 (n = 1019)	June–July 2020 (n = 1125)	June–July 2021 (n = 1001)	July–August 2022 (n = 1051)		
Consumption *		Mean (SD)				Welch's F [†]	p-value
Animal-based dairy products		6.9 (2.7)	6.9 (2.6)	6.8 (2.6)	6.8 (2.6)		
Plant-based milk products		1.7 ^a (2.8)	2.1 ^b (3.1)	2.1 ^b (3)	1.7 ^a (2.9)	6.602 *	<0.001
Animal-based dairy products		Cohort (%)				χ ² ‡, df	p-value
Never		4.5 ^a	4.0 ^a	3.4 ^a	4.5 ^a		
Less than weekly		3.9 ^a	3.0 ^a	4.1 ^a	3.3 ^a	15.979, 9	0.067
Weekly		42.1 ^a	44.4 ^{ab}	48.7 ^b	47.9 ^{ab}		

Table 2. Cont.

	Survey Cohort				Total (n = 4196)		
	June 2019 (n = 1019)	June–July 2020 (n = 1125)	June–July 2021 (n = 1001)	July–August 2022 (n = 1051)			
Everyday	49.5 ^a	48.5 ^a	43.9 ^a	44.3 ^a	46.6		
Plant-based milk products							
Never	64.6 ^a	57.6 ^b	57.1 ^b	65.3 ^a	61.1	27,961, 9	0.001
Less than weekly	9.9 ^a	10.9 ^a	11.0 ^a	9.0 ^a	10.2		
Weekly	18.8 ^{ab}	22.7 ^{bc}	23.8 ^c	17.9 ^a	20.8		
Everyday	6.7 ^a	8.8 ^a	8.1 ^a	7.8 ^a	7.9		

^{abc} mean values in a row with unlike superscript letters were significantly different ($p < 0.05$) based on results of Tamhane's T2 multiple comparison test with Bonferroni-adjusted p -values. * Question wording: Considering the last 12 months (1 year), how often did you eat the following foods, on average? Dairy products (milk, cheese, yogurt); Plant-based milk products (e.g., soy, almond, oat, rice, and macadamia milk). Response options: 0 = Never; 1 ≤ once per month; 2 = 1–3 times per month; 3 = 1 day per week; 4 = 2 days per week; 5 = 3 days per week; 6 = 4 days per week; 7 = 5 days per week; 8 = 6 days per week; 9 = Every day. [†] Welch's F statistic. Significance level $p < 0.05$. Asymptotically F-distributed. [‡] χ^2 , Chi-squared test of independence. df, degrees of freedom.

Some statistically significant differences between cohorts were found for both products. For ABD, the proportion of participants who reported consumption at least once per week (but not every day) increased significantly from 42% in 2019 to 49% in 2021, stabilising at 48% in 2022. For PBM, mean consumption significantly increased from 'less than once per month' in 2019 to '1–3 times per month' in 2020 and 2021 and significantly reduced in 2022, returning to 'less than once per month'. PBM consumers in the 'at least once per week' category increased from 19% in 2019 to 24% in 2021 and reduced from 23% in 2020 to 18% in 2022.

3.3. Variables That Influence the Probability of Belonging to Each Consumption Group

A summary of each consumption group is provided below, which highlights the variables that had a statistically significant influence on the probability of belonging to that consumption group based on the results of the described MNL model. This is followed by a description of the relative impact of statistically significant variables on consumption group membership.

'Exclusive animal-based dairy consumers' constituted 59% of the consumer sample (Table 3). The marginal effects from the MNL model show that the following variables had a statistically significant and independent impact on the probability of being an 'Exclusive animal-based dairy consumer': older age, living without a partner, not having a university education, not coming from an Asian cultural background, following an omnivorous dietary pattern (rather than a flexitarian or vegetarian dietary pattern), identifying price among their top five most important food choice factors when grocery shopping, and not identifying specific individual food choice factors (specifically, novelty, health and nutrition, naturalness, and food tolerance/restrictions) among their top five food choice factors (Table 4).

Table 3. Variable composition of consumption groups assessed in multinomial regression model.

Variable (%)	Exclusive Animal-Based Dairy Consumers (n = 1452, 59%)	Mixed Consumers (n = 961, 39%)	Exclusive Plant-Based Milk Consumers (n = 62, 3%)	Total (n = 2475)	χ^2 [†] , df	p-Value
Female	50.9 ^b	58.5 ^a	64.5 ^{ab}	54.2	16.139, 2	<0.001 *
Mean age (SD) [continuous] min = 18y, max = 76y	51.0 (16.0)	40.2 (14.6)	38.3 (13.7)	46.5 (16.2)	55.614 [‡] , 2	<0.001 * [‡]

Table 3. Cont.

Variable (%)		Exclusive Animal-Based Dairy Consumers (<i>n</i> = 1452, 59%)	Mixed Consumers (<i>n</i> = 961, 39%)	Exclusive Plant-Based Milk Consumers (<i>n</i> = 62, 3%)	Total (<i>n</i> = 2475)	χ ² †, df	<i>p</i> -Value
Age (y)							
	18–24	6.8 ^b	15.2 ^a	21.0 ^a	10.4	269.996, 10	<0.001 *
	25–34	13.6 ^b	26.5 ^a	30.6 ^a	19.1		
	35–44	15.2 ^b	23.9 ^a	16.1 ^{ab}	18.6		
	45–54	17.6 ^a	15.8 ^a	19.4 ^a	17.0		
	55–64	21.0 ^b	10.1 ^a	8.1 ^a	16.4		
	65+	25.7 ^b	8.4 ^a	4.8 ^a	18.5		
University degree		33.2 ^b	50.7 ^a	64.5 ^a	40.8	88.031, 2	<0.001 *
Metropolitan area		65.2 ^b	74.1 ^a	71.0 ^{ab}	68.8	21.332, 2	<0.001 *
Children <18y living in household		28.5 ^b	42.6 ^a	22.6 ^b	33.8	54.573, 2	<0.001 *
Living with partner		61.6 ^{ab}	64.6 ^a	46.8 ^b	62.4	8.895, 2	0.012 *
Cultural background							
	Australian	79.8 ^b	70.2 ^a	80.6 ^{ab}	76.1	29.484, 2	<0.001 *
	Asian [§]	3.4 ^b	13.1 ^a	9.7 ^a	7.4	79.839, 2	<0.001 *
Household income (pre-tax)							
Quintile one (≤AUD 35,000)		27.7 ^b	20.2 ^a	24.2 ^{ab}	24.7	46.665, 8	<0.001 *
Quintile two (AUD 35,001–AUD 65,000)		23.9 ^b	17.9 ^a	27.4 ^{ab}	21.7		
Quintile three (AUD 65,001–AUD 105,000)		21.2 ^b	28.0 ^a	16.1 ^{ab}	23.7		
Quintile four (AUD 105,001–AUD 165,000)		15.6 ^b	19.7 ^a	22.6 ^{ab}	17.4		
Quintile five (>AUD 165,000)		11.6 ^a	14.3 ^a	9.7 ^a	12.6		
Diet pattern [†]							
	Omnivore	81.0 ^c	57.4 ^a	21.0 ^b	70.3	1024.718, 6	<0.001 *
	Flexitarian	15.9 ^b	32.2 ^a	24.2 ^{ab}	22.4		
	Vegetarian	2.5 ^b	9.9 ^a	4.8 ^{ab}	5.5		
	Vegan	0.6 ^a	0.5 ^a	50.0 ^b	1.8		
Psychological variables							
Food choice factors identified among top five most important when grocery shopping ^{††}							
Prosocial							
	Impact on animals	18.1 ^b	24.3 ^a	33.9 ^a	20.9	20.028, 2	<0.001 *
	Environmental impact	11.7 ^b	18.1 ^a	19.4 ^{ab}	14.4	20.499, 2	<0.001 *
	Fairness	13.2 ^a	15.2 ^a	16.1 ^a	14.1	2.081, 2	0.353
Individual							
	Appearance	20.3 ^a	18.3 ^a	12.9 ^a	19.4	3.181, 2	0.204
	Taste	51.4 ^c	43.7 ^a	24.2 ^b	47.7	27.752, 2	<0.001 *
	Food safety	30.0 ^a	29.8 ^a	12.9 ^b	29.5	8.395, 2	0.015 *
	Novelty	4.8 ^b	9.2 ^a	4.8 ^{ab}	6.5	18.168, 2	<0.001 *
	Country of origin	32.2 ^b	25.5 ^a	27.4 ^{ab}	29.5	12.753, 2	0.002 *
	Health and nutrition	41.7 ^a	46.4 ^a	40.3 ^a	43.5	5.552, 2	0.062
	Price	61.9 ^b	49.2 ^a	41.9 ^a	56.5	43.393, 2	<0.001 *
	Convenience	29.3 ^a	25.4 ^a	16.1 ^a	27.4	8.455, 2	0.015 *
	Naturalness	25.3 ^a	28.2 ^a	29.0 ^a	26.5	2.747, 2	0.253
	Familiarity	30.4 ^b	24.3 ^a	12.9 ^a	27.6	17.367, 2	<0.001 *
	How food was produced	15.4 ^b	20.3 ^a	22.6 ^{ab}	17.5	10.928, 2	0.004 *
Food tolerance and restrictions		10.3 ^c	16.6 ^a	33.9 ^b	13.3	43.631, 2	<0.001 *

† χ^2 , Chi-squared test of independence. Significance level $p < 0.05$. Asymptotically distributed (2-sided). df, degrees of freedom. ^{abc} mean values in a row with unlike superscript letters were significantly different ($p < 0.05$) based on results of Tamhane's T2 multiple comparison test with Bonferroni-adjusted p -values. * Significant p -value. ‡ Welch's F statistic. Significance level $p < 0.05$. Asymptotically F-distributed. § Includes Mainland South-East Asian, Maritime South-East Asian, Chinese Asian and Other North-East Asian. || Diet pattern response option wording: Omnivore: I eat most animal products including meat, fish, seafood, and/or

dairy; Semi-Vegetarian/Flexitarian: I am cutting back on meat but not avoiding it completely; Full-time Vegetarian: I do not eat meat but am still eating other animal products; Vegan: I do not eat any animal products. ^{††} Question wording: “How important are the following factors to you when you are grocery shopping for food? Please allocate 100 points among the characteristics based on the IMPORTANCE each has on your purchase decision when grocery shopping for food.

Table 4. Multinomial regression model predicting relationship between sociodemographic and psychological factors associated with animal-based dairy and plant-based milk consumer groups ($n = 2475$).

Variable	Exclusive Animal-Based Dairy Consumers ($n = 1452$, 59%)		Mixed Consumers ($n = 961$, 39%)		Exclusive Plant-Based Milk Consumers ($n = 62$, 3%)	
	Marginal Effect [†]	(SE)	Marginal Effect	(SE)	Marginal Effect	(SE)
Female	−0.018	(0.018)	0.022	(0.018)	−0.003	(0.005)
Age (y)						
18–24	Ref					
25–34	0.028	(0.038)	−0.019	(0.039)	−0.010	(0.012)
35–44	0.076	(0.04)	−0.059	(0.041)	−0.017	(0.013)
45–54	0.172 *	(0.039)	−0.156 *	(0.04)	−0.016	(0.013)
55–64	0.293 *	(0.04)	−0.270 *	(0.04)	−0.023	(0.013)
65+	0.339 *	(0.04)	−0.315 *	(0.04)	−0.024	(0.013)
University degree	−0.056 *	(0.019)	0.038	(0.019)	0.018 *	(0.006)
Metropolitan area	−0.004	(0.02)	0.004	(0.02)	0.000	(0.006)
Children <18y living in household	0.011	(0.022)	0.002	(0.022)	−0.013	(0.007)
Living with partner	−0.045 *	(0.021)	0.053*	(0.021)	−0.008	(0.006)
Cultural background						
Australian	0.038	(0.022)	−0.048 *	(0.022)	0.009	(0.007)
Asian [‡]	−0.204 *	(0.037)	0.189 *	(0.036)	0.015	(0.009)
Household income (pre-tax)						
Quintile one ($\leq$ AUD 35,000)	Ref					
Quintile two (AUD 35,001–AUD 65,000)	0.034	(0.027)	−0.040	(0.027)	0.007	(0.007)
Quintile three (AUD 65,001–AUD 105,000)	−0.037	(0.028)	0.038	(0.028)	−0.001	(0.007)
Quintile four (AUD 105,001–AUD 165,000)	0.001	(0.031)	−0.016	(0.031)	0.016	(0.009)
Quintile five ($>$ AUD 165,000)	−0.002	(0.034)	−0.002	(0.034)	0.005	(0.009)
Diet pattern [§]						
Omnivore	Ref					
Flexitarian	−0.162 *	(0.02)	0.147 *	(0.02)	0.015 *	(0.006)
Vegetarian	−0.264 *	(0.039)	0.253 *	(0.039)	0.011	(0.01)
Vegan	−0.052	(0.108)	−0.035	(0.109)	0.087 *	(0.011)
Psychological variables						
Food choice factors identified among top five most important when grocery shopping [†]						
Prosocial						
Impact on animals	−0.013	(0.023)	0.020	(0.023)	−0.007	(0.006)
Environmental impact	−0.051	(0.026)	0.055*	(0.026)	−0.004	(0.007)
Fairness	−0.016	(0.026)	0.023	(0.026)	−0.007	(0.008)
Individual						
Appearance	−0.008	(0.024)	0.013	(0.024)	−0.005	(0.007)
Taste	0.001	(0.02)	0.012	(0.02)	−0.013 *	(0.006)
Food safety	0.000	(0.021)	0.013	(0.021)	−0.014 *	(0.007)
Novelty	−0.072 *	(0.036)	0.076 *	(0.036)	−0.004	(0.011)
Country of origin	−0.015	(0.021)	0.015	(0.022)	0.000	(0.006)
Health and nutrition	−0.064 *	(0.019)	0.067 *	(0.02)	−0.003	(0.005)
Price	0.044 *	(0.021)	−0.036	(0.021)	−0.008	(0.006)
Convenience	0.017	(0.021)	−0.010	(0.021)	−0.007	(0.006)
Naturalness	−0.049 *	(0.022)	0.047 *	(0.022)	0.003	(0.006)
Familiarity	0.038	(0.021)	−0.028	(0.021)	−0.010	(0.007)

Table 4. Cont.

Variable	Exclusive Animal-Based Dairy Consumers (<i>n</i> = 1452, 59%)		Mixed Consumers (<i>n</i> = 961, 39%)		Exclusive Plant-Based Milk Consumers (<i>n</i> = 62, 3%)	
	Marginal Effect [†]	(SE)	Marginal Effect	(SE)	Marginal Effect	(SE)
How the food was produced	−0.022	(0.025)	0.022	(0.025)	0.000	(0.006)
Food tolerance and restrictions	−0.103 *	(0.027)	0.084 *	(0.027)	0.019 *	(0.006)
Survey cohort	2020	Ref				
	2021	−0.008	0.012	(0.028)	−0.003	(0.008)
	2022	0.028	−0.045	(0.027)	0.017 *	(0.007)

[†] Marginal effects measure impact of factors relative to the control group (animal-based dairy consumers). SE, standard error. * Indicates corresponding Z statistic is significant at 0.05 level. [‡] Includes Mainland South-East Asian, Maritime South-East Asian, Chinese Asian, and Other North-East Asian. [§] Diet pattern response option wording: Omnivore: I eat most animal products including meat, fish, seafood, and/or dairy; Semi-Vegetarian/Flexitarian: I am cutting back on meat but not avoiding it completely; Full-time Vegetarian: I do not eat meat but am still eating other animal products; Vegan: I do not eat any animal products. [‡] Question wording: “How important are the following factors to you when you are grocery shopping for food? Please allocate 100 points among the characteristics based on the IMPORTANCE each has on your purchase decision when grocery shopping for food.”

‘Mixed consumers’ (those who identified as consuming both ABD and PBM in the preceding 12 months), constituted 39% of the sample (Table 3). The following variables had a statistically significant and independent impact on the probability of being a ‘mixed consumer’: younger age; living with a partner; coming from an Asian cultural background; not having an Australian cultural background; following flexitarian or vegetarian dietary pattern (relative to an omnivorous dietary pattern); and identifying environmental impact and several individual food choice factors (novelty, health and nutrition, naturalness, and food tolerance/restrictions) among their top five most important food choice factors when grocery shopping (Table 4).

‘Exclusive plant-based milk consumers’ constituted 3% of the sample (Table 3). The following variables had a statistically significant and independent impact on the probability of being in this group: having a university degree; following a flexitarian or vegan dietary pattern (relative to an omnivorous dietary pattern); identifying food tolerance/restrictions among their top five food choice factors; not identifying taste or food safety among their top five food choice factors; and being in the 2022 survey cohort (relative to the reference year of 2020) (Table 4).

3.4. Relative Impact of Variables on Consumption Groups

Age had the greatest impact on consumption group. Compared to those aged 18–24 years, participants aged 45 years and over were more likely to be ‘exclusive animal-based dairy consumers’ (17–34% greater probability, depending on age group) and less likely to be ‘mixed consumers’ (16–32% lower probability, depending on age group). Dietary pattern had the next highest impact. Compared to omnivores, vegetarians had a 26% lower probability of being ‘exclusive animal-based dairy consumers’ and 25% greater probability of being ‘mixed consumers’; flexitarians had a 16% lower probability of being ‘exclusive animal-based dairy consumers’, a 15% greater probability of being ‘mixed consumers’, and a 1.5% greater probability of being ‘exclusive plant-based milk consumers’; and vegans had a 9% higher probability of being ‘exclusive plant-based milk consumers’. Cultural background also had a relatively large impact on consumption group. Participants with an Asian background had a 19% greater probability of being ‘mixed consumers’ and a 20% lower probability of being ‘exclusive animal-based dairy consumers’.

Other factors that influenced the probability of belonging to a specific consumption group were identifying certain food choice factors amongst the five most important ones

when grocery shopping, living with a partner, and university-level education. Consumers who identified ‘food tolerance and restrictions’, ‘novelty’, ‘health and nutrition’, and ‘naturalness’, among their top five food choice factors when grocery shopping had a 5–8% greater probability of being ‘mixed consumers’ and a 5–10% lower probability of being ‘exclusive animal-based dairy consumers’. Those who identified ‘food tolerance and restrictions’ as a top-five food choice factor also had a 2% higher probability of being an ‘exclusive plant-based milk consumer’. Additionally, consumers who identified ‘price’ among their top five factors had a 5% greater probability of being ‘exclusive animal-based dairy consumer’; consumers who identified ‘environmental impact’ among their top five factors had a 6% greater probability of being ‘mixed consumers’; and consumers who identified ‘taste’ and ‘food safety’ among their top five factors had a 1% lower probability of being ‘exclusive plant-based milk consumers’.

Household composition played a role in consumption, such that consumers who lived with a partner had a 5% greater probability of being ‘mixed consumers’ and a 5% lower probability of being ‘exclusive animal-based dairy consumers’, compared to those living without a partner. Lastly, those with a university degree had a 2% greater probability of being ‘exclusive plant-based milk consumers’ and a 6% lower probability of being an ‘exclusive animal-based dairy consumer’.

Factors that did not statistically significantly influence the probability of belonging to a specific consumption group were presence of children in the household, area of residence (metropolitan vs. other), household income, and certain food choice factors (impact on animals, fairness, appearance, country of origin, convenience, familiarity, and how the food was produced).

4. Discussion

Using data from large and nationally representative samples, this study examined consumption of animal-based dairy and plant-based alternative milk products in Australian adults over time. Three distinct consumption patterns of animal-based dairy and plant-based alternatives—exclusive plant-based milk consumers (PBM), exclusive animal-based dairy consumers (ABD), and those consuming both PBM and ABD—and factors associated with belonging to each consumption group were also investigated. The results suggest that while ABD is consumed more frequently than PBM, there was significantly more variation in PBM consumption over the study period. Key characteristics that predicted membership of each group included older age and not prioritising health and nutrition for membership for ABD-exclusive consumers; cultural background and prioritising food tolerance and restriction for mixed consumers; and veganism and low taste priority for PBM-exclusive consumers. These findings provide novel insights into the consumption of dairy and plant-based milk alternatives in Australian adults, which is expected to be of value to health professionals and both the dairy and plant-based dairy industries. These findings will now be discussed in the context of the extant plant-based food consumption literature in the following sections.

4.1. Changes in Consumption Frequency

Overall, ABD was the leading dairy choice compared to PBM between 2019 and 2022, consistent with recent Australian sales volume data [7,11]. Notably, PBM consumption was more varied than ABD. A small but significant increase in PBM consumption could reflect the growing range of plant-based alternative dairy products made available to Australian consumers in recent years and aligns with others who have also reported increases in PBM consumption [11]. Less expected was the following decrease in PBM consumption from 2020 to 2022. While common barriers, such as price and taste, can affect the uptake of novel food products, differences in the sociodemographic profiles of our survey cohorts may also have contributed to this result. Notable also is the potential impact of the COVID-19 pandemic on food choice behaviour and global food systems dynamics, potentially contributing to the increased likelihood of the 2022 respondents belonging to the exclusive

PBM consumption cohort. Identifying factors linking PBM consumption and the pandemic is beyond the scope of this study. Nevertheless, continued annual monitoring of ABD and PBM consumption would provide greater insight into consumption trends for these product groups in the Australian context. Investigation into the behavioural and external drivers of PBM consumption is another valuable field of inquiry, with potential implications for PBM product formulation and marketing efforts.

4.2. Exclusive Animal-Based Dairy Consumers

ABD consumers formed the largest cohort of our sample, a finding consistent with previous Australian sales volume data and US household purchase data [7,17]. Based on the results of the MNL model, older adults were more likely to be exclusive ABD consumers. These findings align with reports from North America, with older consumers more likely to purchase animal-based dairy milk over plant-based milk alternatives [17] and younger individuals showing a stronger preference for milk alternatives relative to dairy milk [26]. Product familiarity may underpin preferences for animal-based dairy among older age groups. With dairy alternatives introduced to the Australian market in the 1980s, animal-based dairy products were the default dietary staple available during key stages of food choice pattern development for older cohorts [27,28] and these taste preferences and habitual food choices seem to persist. The effect of product familiarity on choice across age cohorts is worth further investigation, with findings potentially informing dairy alternative product design for increased uptake among this key cohort.

Unexpectedly, selecting health and nutrition as a top factor influencing food choice reduced the probability of being an exclusive ABD consumer and increased the probability of being a mixed consumer. While health-related motivations have previously been associated with both animal-based dairy and alternative dairy consumers [12], knowledge of health benefits has also specifically predicted animal-based milk consumption in some consumer segments [29]. Further, health outcomes and dairy consumption are of particular importance for the Australian ageing population, where national dietary guidelines advise increased dairy servings in women over 50 and men over 70 years for bone health [6]. The discussion is ongoing regarding the adequacy of the nutritional profile of animal-based versus plant-based dairy products [30,31]. Nonetheless, identifying sustainable and sufficiently nutritious food sources for the growing older population is an environmental and public health priority [14], and the behavioural mechanisms driving dairy preferences for older individuals is therefore of considerable interest.

4.3. Exclusive Plant-Based Milk Consumers

Exclusive PBM consumers were least common in our sample. Following a vegan diet pattern was the most significant factor associated with group membership. Less expected was the lack of significance of prosocial food choice factors for this cohort, including impact on animals and environmental impact, that have been commonly associated with veganism [32,33]. While ‘green’ marketing, including animal welfare and environmental impact messaging, is increasingly recommended as an effective marketing strategy [34], our findings and those of Slade and Markevych [26] suggest these efforts could also be directed towards other product attributes of plant-based milk products.

Interestingly, our results indicate a small but significant likelihood of flexitarians (part-time animal meat eaters) engaging in exclusive PBM consumption, suggesting that some flexitarians may engage in ‘stricter’ dietary behaviours in relation to dairy intake than with meat. Alternative dietary proteins are a growing field of research, with popular animal protein sources perceived as less environmentally sustainable by consumers and novel protein production technologies in development [12,33]. However, relative to meat and meat alternatives, there has been less focus on choices and dietary patterns related to dairy and dairy alternatives. The present study contributes to this literature and highlights a need for a deeper understanding of consumer behaviour related to these products.

Exclusive PBM consumers were less likely to prioritise taste when choosing food items. Taste is often cited as a value held by ABD consumers and a barrier to PBM consumption [35–37]. Adequate flavour has been reported by consumers as necessary for both milk and non-dairy-alternative products and may play a key role in consumption habit formation [12]. Research concerning a PBM taste profile is ongoing, with one study finding consumers preferred the sweet and creamy attributes of PBM alternatives but simultaneously disliked the beany and ‘off-flavours’ arising from alternative milk processing methods [20,38]. While there is basis for manufacturers to imitate dairy milk-like sensory characteristics in PBM formulation to broaden product appeal, our results indicate that existing exclusive PBM consumers may not be influenced by these efforts.

4.4. Mixed Consumers

In contrast to the exclusive ABD consumer cohort, members who consumed both animal- and plant-based dairy were younger, which is consistent with UK-based research [35]. Mixed consumers were also more likely to come from an Asian cultural background rather than an Australian one. Cultural ideals are one of many factors shaping food choice values [39]. Only one of the few Australian studies on this topic has previously identified an Asian cultural background to be associated with the consumption of soy milk over animal milk [20]. However, US-based studies have also indicated that households comprising Caucasian and non-Caucasian consumers are more likely to purchase animal-based dairy milk and specialty milk types, respectively [17,40]. Further, product familiarity may be influencing this demographic similarly to ABD consumers, with soy milk developed and introduced in Asia in the 1940s compared to its US and European release in the 1970s and 1980s. Tracking consumer preferences and demographics against dairy product availability in Australian food choice environments may be of interest to domestic and international producers.

Diet pattern was also a key indicator of mixed consumption. Contrary to exclusive ABD consumers, mixed consumers were significantly more likely to report following a flexitarian or vegetarian diet. This result suggests that PBM is an acceptable option for those already reducing animal meat products in their diets, presenting a synergistic marketing opportunity for this cohort. A deeper interrogation of diet pattern in the context of milk-type preference would further inform the consumer profiles presented here and could follow a segmentation analysis approach [22].

Food tolerance and dietary restrictions significantly influenced dairy product choice for all consumer cohorts studied. Lactose intolerance is an example of a food intolerance estimated to affect up to 70% of the world’s population and can lead to partial or complete avoidance of dairy milks [29]; notably, only 4.5% of Australians report to avoid dairy [5]. Unexpectedly, mixed consumers were most likely to prioritise food tolerance and restriction when grocery shopping, despite consuming some animal-based dairy products. Potential explanations include consuming animal-based but lactose-free dairy products, or having non-dairy-related food intolerances which was not specifically asked about in this survey. Lactose-intolerant individuals have also been reported to consume lactose products despite discomfort, or in small amounts without consequence [12], which may be necessitated by the relatively limited range of lactose-free and/or alternative dairy products. These findings may provide insight for healthcare professionals and warrant extending the current study scope to include lactose-free dairy products and lactose-intolerance-dedicated survey items.

The intersection of ethnicity and food tolerance requirements may also be of particular interest to the domestic and international PBM markets. The proportion of Australians with an Asian ethnic backgrounds is increasing, with 17.4% of the Australian population registering Asian ancestry in the 2021 census [41]. Given the high incidence of lactose intolerance among Asian and several other non-Caucasian cohorts, PBM producers may reach a larger audience by engaging with a broad range of cultural demographics [42].

4.5. Limitations and Future Research

The strengths of this study include the recruitment of a sizeable, largely nationally representative sample and its resulting statistical power. However, several biases are inherent to self-reported survey data. Self-selection bias can prompt respondents with a particular interest in the survey topic to respond, causing non-random sample recruitment [43]. Questions evoking social issues, such as animal and environmental justice, can encourage social desirability bias, where societal expectations may inform responses rather than lived experience [44]. Food consumption recall questionnaires, such as FoodIQ, are also limited by recall bias which may affect the accuracy of consumption data [45]. Further complicating product choice recall is the potential confusion caused by product naming schemes common to protein-alternative products, e.g., ‘milk’ (standard name for animal-derived milk in Australia) versus ‘milk’ (referring to plant-based milk). While this naming convention has been clarified in other countries, Australian standards do not prohibit plant-based drinks to be marketed as ‘milk’, although a review of the practice is ongoing [46]. To overcome inaccurate data collection caused by this naming convention, future research could capture explicit product choices made by participants at the point of purchase.

The current study design is limited by product type comparison. While consumption data concerning ABD products (animal-based dairy, including milk, cheese, and yoghurt) and PBM products (plant-based milk) were directly compared during the analysis, these product groups are not equivalent; this issue was also encountered by Adamczyk et al. [47]. The survey instrument could be altered to include the broader plant-based dairy product group, working towards understanding associations with and uses for plant-based cheese and yoghurt alternatives, too. This expanded understanding would complement the predicted increase in availability of plant-based dairy alternative product types [48], with the insights being of particular use to healthcare professionals working with lactose-intolerant individuals or those following dietary patterns such as veganism.

5. Conclusions

Consumer food choice is a critical lever in the transition to more sustainable food systems. Taken together, our findings illustrate how sociodemographic and food choice factors differ between consumers of PBM and/or ABD, providing a foothold to reach important segments of the dairy and alternative consumer market. Despite the context of a growing alternative milk market in Australia and abroad, our study highlights that the PBM uptake in Australia is relatively low compared to ABD, and only a minority of Australians are exclusive consumers of PBM at this point. In this context, the ‘mixed’ consumer group should not be underestimated as a driving force in the transition to wider PBM acceptance. As a large cohort who have ‘taken the plunge’ and incorporated milk alternatives into their diets, the future of more environmentally sustainable alternative milk consumption in Australia is likely to be influenced by ‘mixed’ consumers and their requirements. Overall, the consumer insights presented are of interest to sustainable food systems development stakeholders, with a high relevance to the public health and food promotion sectors.

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