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# How Neighbourhood Food Environments and a Pay-as-You-Throw (PAYT) Waste Program Impact Household Food Waste Disposal in the City of Toronto

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**Abstract:** Household food waste has negative, and largely unnecessary, environmental, social and economic impacts. A better understanding of current household food waste disposal is needed to help develop and implement effective interventions to reduce food wasting. A four-season waste characterization study was undertaken with 200 single-family households across eight neighbourhoods in Toronto, Ontario, Canada. The City of Toronto provides residents with a pay-as-you-throw (PAYT) waste program that includes a choice of four garbage cart sizes (Small [S], Medium [M], Large [L], Extra Large [XL]), with increasing annual user fees (\$18.00–\$411.00 CAD), as well as a green cart (organic waste) and blue cart (recycling). On average, each household disposed 4.22 kg/week of total food waste, 69.90% of which was disposed in the green cart, and disposal increased significantly ( $p = 0.03$ ) by garbage cart size to L but not XL garbage carts. Of this total, 61.78% consisted of avoidable food waste, annually valued at \$630.00–\$847.00 CAD/household. Toronto's PAYT waste program has been effective at diverting food waste into the green cart but not at reducing its generation. Higher median incomes were positively correlated, while higher neighbourhood dwelling and population density were negatively correlated, with total and avoidable food waste disposal. Regression analyses explained 40–67% of the variance in total avoidable food waste disposal. Higher supermarket density and distance to healthier food outlets were associated with more, while dwelling density was related to less, total and avoidable food waste disposal. Distance to fast food restaurants and less healthy food outlet density were both negatively associated with avoidable food waste disposal in the garbage and green cart, respectively. Avoidable food waste reduction interventions could include increasing garbage cart fees, weight-based PAYT, or messaging to households on the monetary value of avoidable food waste, and working with food retailers to improve how households shop for their food.

**Keywords:** food waste; waste characterization study; pay-as-you-throw (PAYT); neighbourhood food environments; food geography

## 1. Introduction

Food waste is a societal inefficiency that spans the various parts of the food supply chain, and results in negative, and largely unnecessary, environmental, social and economic impacts. It can be divided into avoidable food waste, which is food that was at one point edible, or unavoidable food waste (e.g., vegetable peels, bones) [1,2]. In the face of declared ‘climate emergencies’, food insecurity and squandered monetary resources, there is considerable urgency and commensurate effort by academics and waste professionals to better understand this problem and ultimately facilitate the development and implementation of efficacious avoidable food waste reduction interventions [3]. In this study we used direct measurement of curbside waste samples to quantify and better understand curbside household food waste disposal in the City of Toronto, Ontario, Canada (hereafter ‘City’ or ‘Toronto’). Toronto is the largest city in Canada, with a population of over 2.8 million. We also measured potential associations between curbside food waste disposal with their pay-as-you-throw (PAYT) waste program, sociodemographic, socioeconomic and neighbourhood food environment variables.

There has been a proliferation of global and countrywide food waste estimates, encompassing all or part of the food supply chain [4–6]. These estimates, while interesting for presenting the scope of the problem, use inferential approaches that do not include any direct food waste measurement. This exclusion results in unverifiable estimates which are also difficult to apply to the generally smaller geographic scales in which food waste reduction interventions would be implemented. Further, accurate baseline measurements are important to understand the extent of the problem, inform intervention development, and ultimately to be used as a comparator to assess intervention success.

A recent systematic review of food waste in developed countries (e.g., Canada, United Kingdom, United States) estimated that mean food waste across the food supply chain was 198.9 kg/capita/year [7]. The biggest food waste contributor was consumers (households), who threw out a mean of 114.3 kg/capita/year (SD = 68.7), with a broad range of estimates from 18.8 kg/capita/year [8] to 396 kg/capita/year [9]. The review identified the key issue of how food waste is measured (i.e., whether it was indirect using inferential data, or direct using collected/sorted/weighed samples), and recommended, as have other researchers, the direct collection of food waste data [7,10–14]. Some researchers [14,15] have suggested that self-reported (i.e., a form of indirect data collection) household food waste results should be used with caution as they may underestimate food waste disposal.

In an examination of 2012–2015 directly measured waste composition data from nine Ontario, Canada municipalities, the mean quantity of food waste disposed (to landfill) was 2.4 kg/household/week (range of 1.8–3.1 kg/household/week) [16], and this included municipalities that had curbside green cart programs to divert food waste. Another study, undertaken in London, Ontario, a city without a green cart program, showed households disposed a range of 2.4–3.4 kg/household/week [17]. Meanwhile, in nearby Guelph, Ontario, a city with a green cart program, it was estimated that households disposed 4.4 kg/household/week [18]. It was anticipated that quantities of household food waste disposed in Toronto, which is nearby but much larger than both Guelph and London, would be similar to other municipalities with green cart programs. However, the impact of a PAYT program specifically on food waste disposal is unknown, as it has not previously been studied.

## 2. PAYT Waste Management Programs

Economic instruments such as PAYT (sometimes referred to as User Pay) provide households with a financial incentive to minimize waste generation [19]. The different types of PAYT have been well summarized [20] and can include volume-based (i.e., different sizes of containers, garbage tags/pre-paid garbage bags) and less commonly weight-based (i.e., weight data collected during collection) approaches [21]. Previous studies reported that the lowest PAYT garbage disposal and highest recycling rates came from weight-based approaches, followed by volume-based approaches including bag tags/pre-paid garbage bags and then different sized garbage containers [21,22]. They tend to have a positive impact on the re-use and recycling of wastes but less so in terms of overall waste generation [23].

Dahlén and Lagerkvist [24] reported that households with a weight-based scheme generated 20% less household waste than households that did not have this program and that this did not appear attributable to higher recycling rates. A study of PAYT communities in Japan reported that there was a 20–30% decrease in waste generation that was attributable to increased recycling and source reduction [25]. In a study from the United States, PAYT waste program households achieved approximately a 17% decrease in household garbage disposal, with two-thirds of this attributed to diversion to recycling programs and the remaining one-third to source reduction [20].

In Ontario, Canada, there are more than 100 municipalities with some sort of PAYT waste program, which consists mostly of volume-based garbage tags, [26] although some municipalities such as Toronto levy variable user fees depending on the size (Small [S], Medium [M], Large [L] or Extra Large [XL]) of the municipally-supplied garbage cart. A recent study showed that there was a statistically significant relationship between PAYT waste programs and a higher level of municipal waste diversion, and the impact appears more pronounced in urban than rural municipalities [26].

To date, the effects of PAYT on food waste disposal have not been specifically investigated, although based on previous studies a reduction would be expected [27,28]. This type of economic tool could attract those that are not reached by awareness campaigns. Further, a study on food waste drivers [29] suggest that the transition of municipal waste collection systems towards a volume-based approach or reducing collection frequency could be an effective food waste reduction policy. In the United States, PAYT programs have been used to increase participation in food waste diversion programs [30], although any impact on food waste reduction was not measured. However, in an analysis of household food waste generation across 44 countries, Chalak, Abou-Daher, Chaaban and Abiad [19] concluded that economic measures, such as PAYT, were less effective than well-defined regulations, policies and strategies in reducing household food waste generation.

### 3. Neighbourhood Food Environments

The neighbourhood food environment generally refers to the location and accessibility of different places to buy food in a neighbourhood. Neighbourhood food environments are typically characterized quantitatively in terms of the population's proximity to, or the density of, different types of food retail outlets within a neighbourhood, or an areal unit chosen to represent a neighbourhood (e.g., census tract, dissemination area, ward, or school catchment area) [31,32]. The food retail outlets most studied include grocery stores, convenience stores, fast food restaurants (i.e., pay at counter, takeout) and full-service restaurants (i.e., with sit down table service) [33]. Grocery stores, including supermarkets, fruit and vegetables sellers, and farmers' markets are most commonly referred to as 'healthy' [31], whereas convenience stores and fast food restaurants are typically lumped together as 'unhealthy' (ignoring that most retail food outlets sell both healthy and unhealthy foods) [33,34]. Researchers have used various measures of accessibility to healthy and less healthy food outlets to explore the impact of the neighbourhood food environment on food purchasing patterns, dietary habits, and health-related outcomes (e.g., body mass index) of neighbourhood residents of varying sociodemographic and socioeconomic characteristics; however, to date, little to no research has explored the impact of food environments on household food waste.

#### 3.1. Socioeconomic and Sociodemographic Characteristics and Food Access

A systematic review of 'food deserts', or socioeconomically disadvantaged areas with poor access to retailers of healthy and affordable food (i.e., supermarkets or healthier food outlets), found clear evidence of food access disparities, by income and race, in the United States [35]. Socio-economically disadvantaged neighbourhoods (e.g., high-poverty/high-minority) in the United States appear to have poorer access to healthy foods than more socio-economically advantaged areas, and greater availability of less healthy food outlets; this disparity negatively impacts dietary outcomes [36]. Conversely, other studies have shown that high-poverty/high-minority areas, within higher density neighbourhoods have comparatively greater availability of grocery, convenience stores and fast food restaurants, relative to

low-poverty/low-minority areas [37]. While previous work has identified food deserts in the mid-sized Canadian city of London, Ontario [31], evidence of 'food deserts' in other cities in Canada, UK and Australia appears weak [31,35,38,39].

### 3.2. Linking Food Environments, Purchasing Behaviours, Diet and Health Outcomes

Several food environment studies have found greater concentrations of fast food and convenience stores [40,41] in low-income neighbourhoods, suggesting that vulnerable populations are more highly exposed to unhealthy foods, are more likely to purchase unhealthy foods and are at a greater risk of having unhealthy diets [42,43]. Research has also shown that adults may actually experience highest overall exposure to fast food outlets while at their workplaces [44], and children are more heavily exposed to fast food outlets and convenience stores near their schools [40,42,43]. One Canadian study used GPS tracking to show how adolescents' exposure to unhealthy food outlets between home and school had a significant effect on the likelihood of purchasing 'junk food' (i.e., food that is high in calories but low in nutritional content) [45].

Several large-scale studies of US populations have shown that adult obesity rates are positively associated with the density of neighbourhood fast food outlets and convenience stores [46,47]. For example, a cross-sectional, multilevel analysis of New York City adults showed a positive association between these less healthy food outlets and BMI, and this relationship was more pronounced in higher poverty areas [48]. Studies of children in the UK [49] and Australia [50] have found that the greater availability of fast food outlets and convenience stores close to home has a negative effect on children's fruit and vegetable intake. Meanwhile, a series of Canadian studies found that the availability of fast food outlets and convenience stores within close proximity of elementary schools is linked to increased junk food purchasing [34], poorer overall diet quality [51] and higher body mass index (BMI z-scores) [52] of students.

Findings on the influence of accessibility (density and proximity) of neighbourhood grocery stores and supermarkets on purchasing, diets and health outcomes are more mixed. One study of food stamp users in Kentucky showed that lower income adults who lived within 0.8 km of a farmer's market were more likely to consume one or more servings of vegetables and milk and at least five servings of grains daily [53]. Similarly, if they lived within 0.8 km of a healthier food outlet, they were also more likely to consume at least one serving of vegetables per day [53]. A study of food access and children's BMI in Toronto found that living in an area with a higher density of healthy food outlets and in close proximity to a supermarket decreased the odds of being overweight or obese [54]. On the other hand, a study set in the Canadian province of Québec noted that children's diets did not appear to be associated with access to supermarkets; however, residing in neighbourhoods with lower access to fast food restaurants and convenience stores was associated with a lower likelihood of eating and snacking out. [37]. Similarly, a study of adolescent girls in the US showed there were no associations with living in a food desert on consumption of fruits and vegetables; however, girls living in 'food swamps' (areas with high density of unhealthy relative to healthy outlets) consumed more snacks/desserts than girls who did not [55].

Taken together, the results of the various studies suggest that the characteristics of the neighbourhood food environment differ with socioeconomic status and also have an influence on the food purchasing and dietary behaviours of residents. However, proximity to a grocery store does not appear to have as strong an association with purchasing, diet quality and health outcomes as proximity to less healthy food outlets (i.e., fast food, convenience store) impact the consumption of unhealthy, nutrient-poor foods. If the makeup of a neighbourhood food environment has an influence on the purchasing and consumption of food, then it stands to reason that food environments may also impact food waste generation and disposal. It raises questions such as, does more convenient access to food retail outlets translate into more food waste disposal? While Cohen [56] advocates for the integration of upstream and downstream food metrics to better understand the food system and improve policy making, there has been very little research linking downstream food waste disposal with

the upstream neighbourhood food environment. In a recent study, the results of a food purchasing and food expiration modelling exercise showed that there is an optimal grocery store density with regard to household food wasting and that most American cities are well below this optimal density [57]. In one example, the addition of a few more stores could result in an estimated 6–9% reduction in retail and household food waste [57].

#### 4. This Study

Toronto offers its single-family households one of four garbage cart sizes (S—small, M—medium, L—large, XL—extra-large) and empties them every two weeks if set out to the curb on their waste collection day. In this PAYT waste program, households are levied a fee, which is progressively higher by garbage cart size selected. Households are also provided, at no additional cost, with a blue cart for recycling which is emptied every two weeks and a green cart (one size) for organic wastes including food waste, which is emptied every week. For this study, we measured the quantity of curbside household food waste disposal over four seasons in eight neighbourhoods (i.e., sampling areas).

Food waste disposal was broadly examined and encompassed food that was placed in the garbage cart, the green cart (i.e., diversion to anaerobic digestion) and the blue cart (i.e., diversion to recycling). Food was sub-divided into avoidable and unavoidable food waste and various sub-categories (e.g., bakery).

The purpose of this study was to answer three research questions. (1) What is the impact of household garbage cart size on food waste disposal? (2) What is the seasonal impact on food waste disposal? (3) What sociodemographic, socioeconomic and neighbourhood food environment variables are associated with food waste disposal?

We posed the following hypotheses related to these research questions: (1) Households with larger garbage carts will dispose of more food than households with smaller garbage carts; (2) Households with higher incomes will dispose of more food than households with lower incomes; (3a) Households in closer proximity to supermarkets will dispose of less food than households that are further away from supermarkets; and (3b) Households in closer proximity to fast food outlets will dispose of more food than households that are further away from fast food outlets.

#### 5. Materials and Methods

A four-season single-family household waste characterization study was undertaken in Toronto from October 2015 to July 2016. This consisted of the collection and manual sorting of curbside waste samples from 200 households. Each seasonal study (i.e., fall, winter, spring, summer) took place over a two-consecutive-week period, which represented a full waste management cycle (i.e., bi-weekly collection of garbage and recyclables and weekly collection of organics) and included detailed measurement of food waste.

##### 5.1. Dependent Variables: Sample Collection and Sorting

The City selected four representative sampling areas (i.e., neighbourhoods) of 25 consecutive single-family homes in each of its two waste collections districts. Four of these sampling areas (i.e., 100 homes) were in the northwestern part of the city and four (i.e., 100 homes) in the southeastern part of the city. The City selected sampling areas to reflect average distribution of garbage cart sizes. Sample area selection included a drive through by City staff to ensure that only single-family homes (as opposed to duplexes, multi-tenant houses) were included.

All waste streams are deposited by households into City provided carts, which are placed at the curb on their waste collection day. During each two-week seasonal study period, curbside waste samples were collected from sample areas on their waste collection days (i.e., garbage and green cart one week and blue cart and green cart the other week). They were collected by a sampling crew prior to the arrival of regular waste collection crews. Samples were bagged and labelled by sampling area and garbage cart size and taken to an indoor sorting facility.

Blue cart and green cart samples from each sampling area were pivoted by the size of the household garbage cart from which they were collected. For each sampling area, this provided a profile of garbage in S, M, L and XL carts and respective blue and green cart profiles for each of these garbage cart sizes. Waste samples from all three streams were manually sorted by the sampling crew into 12 food waste categories (i.e., avoidable and unavoidable bakery, meat and fish, dried food [e.g., pasta, rice], fruit and vegetables, dairy and other food) and weighed (using A&D SK-5001WP scale, Wood Dale, IL, USA; 5000 g capacity, sensitive to 1 g). The dependent variables for this study included: total food waste, total avoidable food waste in the garbage and green cart streams and total avoidable food waste by food waste categories.

## 5.2. Independent Variables

Independent variables that were of interest in this study for their potential association with the above noted dependent variables of food waste disposal included PAYT, sociodemographic, socioeconomic and neighborhood food environment variables.

### 5.2.1. PAYT Variables

PAYT variables include garbage cart size (S, M, L, XL), garbage and green cart set out (i.e., was a particular cart set out to the curb on a household's waste collection day) and participation (i.e., did a household set out a particular cart at least once during the study).

### 5.2.2. Sociodemographic and Socioeconomic Variables

The locations of each sampled home were geocoded to the exact address using ArcGIS (Version 10.3). A 1 km walking network was calculated around each sampled home in ArcGIS using a walking network (comprised of sidewalks, pathways, and streets, but excluding highways) derived from the 2015 street centerline file available from the Toronto's open data site [58]. This 1 km walking network was used as the areal unit for calculating neighbourhood sociodemographic and socioeconomic variables, as well as dimensions of the neighbourhood food environment. Sociodemographic and socioeconomic variables, including population density, dwelling density and median household income were compiled for each sampling area, using data from the 2011 Census [59] at the dissemination area (DA) level, which is the smallest areal unit for which Statistics Canada releases income data and is a reliable proxy for each sampling area [60].

A population density variable was compiled for each sampling area based on the 1 km walking network and the 2011 census block population. The average population density (population count/total area) for all census blocks within the 1 km walking network was calculated to represent population density around the home. Additionally, average dwelling density (number of dwellings/total area) for all census blocks within the 1 km walking network was calculated to represent the density of dwellings in the home neighbourhood. Census data [59] were also used to obtain the median household income for the neighbourhood. Each home was assigned an income value based on their home dissemination area DA (e.g., if a home was in a DA with a median household income of \$55,000 CAD, this was the value assigned to the household).

### 5.2.3. Neighbourhood Food Environment Variables

The neighbourhood food environment was also characterized for each sampling area. This included consideration of the distance to the nearest, average distance to the nearest three, number within a 1 km buffer, and density within a 1 km buffer for four different food outlet types: fast food outlets; less healthy food outlets; healthier food outlets; and supermarkets.

All food outlet information was obtained from Toronto Public Health's 2015 Toronto Healthy Environments Inspection System (THEIS) [61]. The definitions regarding the type of food outlet were classified based on data within the THEIS, through inspection of the food sold at each establishment and through previous research using the THEIS dataset [54].

Fast food locations were classified in THEIS as a restaurant, cafeteria, food court vendor, food take out, hotdog cart, or ice cream/yogurt vendor with limited or no wait staff, takeout available, and customers having to pay prior to receiving food. Any outlet with limited access (i.e., in a venue where a ticket is required such as a concert venue or stadium) were excluded as they are not easily accessible to the public.

Healthier food outlets were classified in the THEIS as a bake shop, bakery, butcher shop, fish shop, food store (convenience/variety), or supermarket; and if they sold a significant quantity and diversity of vegetables and/or fruit or specialized in one category of Canada's Food Guide (e.g., vegetables and fruit, grain products, milk and alternatives, meat and alternatives). All establishments that did not meet this criterion were defined as less healthy food outlets, which includes fast food restaurants and convenience/food stores that do not specialize or sell a significant quantity of vegetables/fruit, grain products, milk/alternatives or meat/alternatives.

Classification of supermarkets was merely all stores identified in THEIS as a supermarket, defined as "a food store that offers a large volume of food for sale and is multifunctional and may include specialty departments/units such as delis, butcher shops, bakeries or seafood counters" [62]. Supermarkets are also classified as a healthier food outlet as they do sell a significant quantity of vegetables/fruit, grain products, milk/alternatives or meat/alternatives.

Following the methods used in other food accessibility studies, [31,54,63] both proximity and density measures of food access were examined. All food outlets were geocoded to the exact address. To assess the density of food outlets, once again 1 km walking network buffers around the sampled homes were used to determine access. A distance of 1 km was applied as it relates to previous work on food access [31,54,63], and represents easy access within the home neighbourhood. The numbers of fast food restaurants, supermarkets, healthier and less healthy food outlets within each 1 km home network were calculated. Values were then weighted based on the land area (in km<sup>2</sup>) within each home buffer to create a density variable for each type of food outlet. In relation to food access, greater density relates to better accessibility and/or greater exposure.

The distance from each sampled home to the nearest fast food restaurant, supermarket, healthier and less healthy food outlet was also examined along the walking network to obtain a distance to the nearest outlet. This provides basic proximity to the nearest food store of each type. The process was repeated to find a distance to the nearest three outlets as well. Distance to three outlets was examined to get a better understanding of how far people must travel to achieve variety or 'choice' in their food environments [32,63]. In Toronto, due to the multicultural makeup of the city, variety may be even more important as different ethnic foods may only be available at certain outlets.

### 5.3. Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 25 (Armonk, New York). For each season, data were aggregated and summarized to present descriptive information on the quantity and type of food waste disposed in the various waste streams. Continuous variables were presented as mean and  $\pm$  standard deviation (SD).

Four of the sampling areas did not have any homes with XL carts. To maximize statistical power and avoid listwise deletion, data (i.e., means) were imputed and a sensitivity analysis was undertaken with data that were not imputed to assess whether the findings were consistent. A repeated measures ANOVA was used to compare mean differences in food waste disposal by household garbage cart size and season. Bivariate correlation and regression analysis were undertaken on the dependent variables total food waste, avoidable food waste and avoidable food waste by food waste type. The Spearman's rank correlation coefficient was used to assess the strength and direction of the association between the quantity of food wasted with the various independent variables. Correlation coefficients were interpreted as follows:  $\geq 0.75$ , very good to excellent; 0.50–0.75, moderate to good; 0.25–0.49, fair; and  $\leq 0.25$ , little to no correlation [64]. Multiple linear regression models were developed to assess the relative effects of various predictors on total, avoidable and food type disposal. A 2-sided  $p$ -value  $\leq 0.05$

was considered statistically significant. Regression  $R^2$  effect sizes were interpreted as follows:  $\geq 0.35$ , large;  $\geq 0.15$ , medium; and  $\geq 0.02$ , small [65]. Additional correlation analysis was undertaken to assess the bivariate strength of socio-demographic/socio-economic and neighbourhood food environment variables that were significant in regression models.

## 6. Results

### 6.1. Food Waste Disposal and PAYT

Households disposed an average of 4.22 kg/week of food waste, with 69.90% placed in the green cart (Table 1), and the rest placed mostly in the garbage cart, with very small amounts inappropriately placed in the blue cart (food waste in the blue carts was therefore not analyzed further).

**Table 1.** Total Food Waste by Waste Stream.

Waste Stream	Mean	SD	Mean	
	kg/household/week		%	kg/household/year
Garbage cart	1.08	0.67	25.49	56.00
Blue cart	0.19	0.14	4.60	10.11
Green cart	2.95	0.38	69.90	153.55
Total	4.22	0.76	100.00	219.66

Repeated measures ANOVA was used to examine the impact of both seasons and garbage cart size on total, garbage cart, and green cart food waste. There were no significant seasonal differences in mean total food waste (3.86–4.38 kg/household/week;  $p = 0.55$ ); in the garbage cart (0.84–1.14 kg/household/week;  $p = 0.33$ ); and in the green cart (2.88–3.10 kg/household/week;  $p = 0.71$ ).

Total food waste disposed ranged from 3.22–4.98 kg/household/week and increased by garbage cart size to L garbage carts, and then declined for households with XL garbage carts (Table 2). The amount of food waste was significantly different ( $p = 0.03$ ), depending on garbage cart size. Households with S garbage carts threw out significantly less food waste than households with L and XL garbage carts. Further, households with XL carts only disposed significantly more food waste than households with S garbage carts.

**Table 2.** Mean Food Waste Disposed by Garbage Cart Size Across Four Seasons (kg/household/week) \*.

Garbage Cart Size		Total Food Waste	Garbage Stream	Green Cart Stream
Small		3.22 <sup>a</sup>	0.29 <sup>a</sup>	2.81
	SD	1.49	0.28	1.47
Medium		3.96 <sup>ab</sup>	0.59 <sup>b</sup>	3.28
	SD	1.56	0.50	1.48
Large		4.98 <sup>b</sup>	1.56 <sup>c</sup>	3.15
	SD	1.43	0.98	1.01
Extra Large		4.49 <sup>bc</sup>	1.76 <sup>c</sup>	2.48
	SD	1.26	0.58	0.98
		$p = 0.03$	$p = 0.001$	$p = 0.48$

\* Means sharing the same superscript in a column are not significantly different from each other (LSD,  $p < 0.05$ ).

Food waste disposed in the garbage cart ranged from 0.29–1.76 kg/household/week and increased by garbage cart size (Table 2). The amount of food waste was significantly different ( $p = 0.001$ ), depending on garbage cart size. Households with S garbage carts threw out significantly less food waste than all other garbage cart sizes, and households with XL garbage carts threw out more food waste than all garbage carts except for households with L garbage carts, and this impact was similar across the four seasons (Table 3). The seasonal results essentially mirrored mean food waste in the garbage cart, except that the amount of food waste in XL garbage carts was significantly lower in

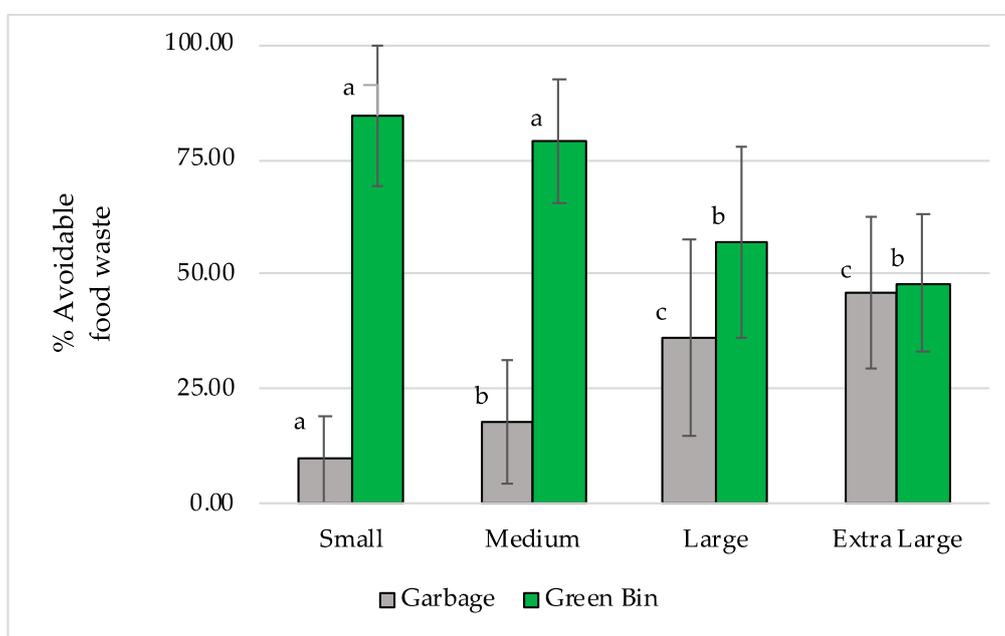
the summer than the other three seasons. Food waste disposed in the green cart stream ranged from 2.48–3.28 kg/household/week. There were no significant differences in green cart food waste by garbage cart size (Table 2).

**Table 3.** Food Waste Disposed in the Garbage Cart by Individual Season and Garbage Cart Size (kg/household/week) \*.

Garbage Cart Size		Fall 2015	Winter 2016	Spring 2016	Summer 2016	
Small		0.24 <sup>a</sup>	0.13 <sup>a</sup>	0.54 <sup>a</sup>	0.24 <sup>a</sup>	$p = 0.08$
	SD	0.19	0.12	0.52	0.29	
Medium		0.72 <sup>b</sup>	0.64 <sup>b</sup>	0.63 <sup>a</sup>	0.39 <sup>a</sup>	$p = 0.44$
	SD	0.48	0.38	0.82	0.33	
Large		1.98 <sup>c</sup>	1.22 <sup>c</sup>	1.48 <sup>b</sup>	1.58 <sup>b</sup>	$p = 0.35$
	SD	1.31	0.64	1.21	0.75	
Extra Large		1.76 <sup>c</sup>	2.21 <sup>d</sup>	1.92 <sup>b</sup>	1.14 <sup>b</sup>	$p = 0.01$
	SD	0.89	0.31	0.55	0.34	
		$p = 0.02$	$p < 0.001$	$p < 0.001$	$p < 0.01$	

\* Means sharing the same superscript in a column are not significantly different from each other (LSD,  $p < 0.05$ ).

Approximately three-fifths (61.78%) of total food waste disposed consisted of avoidable food. The proportion of avoidable food waste in the garbage cart increased significantly as garbage cart size increased ( $p < 0.001$ ) but decreased significantly in green carts as garbage cart size increased ( $p < 0.001$ ) (Figure 1). The proportion of avoidable food waste in the garbage of households with S garbage carts was significantly smaller than for households with M, L and XL garbage carts ( $p < 0.01$ ) but not between households with L and XL garbage carts ( $p = 0.08$ ). Conversely, the proportion of avoidable food waste in green carts was significantly higher in households with S and M garbage carts as compared to L and XL garbage carts ( $p < 0.001$ ).



**Figure 1.** Proportion of avoidable food waste in the garbage and green cart streams by household garbage cart size \*. \* Means sharing the same superscript in garbage (gray bars) and green cart (green bars) columns are not significantly different from each other (LSD,  $p < 0.01$ )

The percent of avoidable fruit and vegetable waste was highest and avoidable dairy was lowest across all garbage and green cart sizes (Table 4). In garbage carts the percent avoidable fruit and vegetable waste was followed by one of other food or bakery. In green carts the percent avoidable fruit and vegetable waste was followed by dried food for households with S and M garbage carts; bakery for households with L garbage carts; and meat and fish for households with XL garbage carts.

**Table 4.** Percent Avoidable Food Waste, by Food Waste Type and Household Garbage Cart Size, in Garbage and Green Carts.

Food Type	Garbage cart				Green Cart			
	S	M	L	XL	S	M	L	XL
Bakery	18.92	17.09	13.74	17.84	12.42	11.87	14.41	10.55
Meat and Fish	16.22	11.97	15.32	17.72	12.67	13.47	9.96	15.13
Dried Food	8.11	8.82	8.78	8.05	14.46	14.07	11.71	10.84
Fruit and Vegetables	29.73	33.61	35.74	34.40	45.27	43.85	50.73	43.23
Dairy	5.41	4.10	6.16	7.01	4.44	2.78	3.49	5.25
Other	21.62	24.41	20.26	14.99	10.74	13.95	9.70	15.01

## 6.2. Sociodemographic, Socioeconomic and Neighbourhood Food Environment Variables

Total food waste, total avoidable food waste and avoidable food waste in the green cart was positively correlated with garbage set out, median household income, average distance to nearest three fast food restaurants, distance to nearest less healthy food outlet and average distance to nearest three less healthy food outlets (Table 5). Conversely, total food waste, total avoidable food waste and avoidable food waste in the green cart were negatively correlated with average population and dwelling density, the number of less healthy food outlets within a 1 km buffer, density of fast food outlets within a 1 km buffer, number of healthier food outlets within a 1 km buffer and density of healthier food outlets with a 1 km buffer (Table 5).

Multiple linear regression models were developed for total food waste, total avoidable food waste, avoidable food waste in the garbage cart and avoidable food waste in the green cart and these explained a large amount of the variance.

The amount of total food in all waste streams was positively and significantly impacted by garbage set out, green cart participation, distance to the nearest healthier food outlet, the density of supermarkets within a 1 km radius, but negatively impacted by dwelling density. This regression model explained approximately 67% of the variance (Table 6). The amount of total avoidable food in all waste streams was positively and significantly impacted by green cart set out, distance to the nearest healthier food outlet and the density of supermarkets within a 1 km radius, but negatively and significantly impacted by dwelling density. This regression model explained approximately 55% of the variance (Table 6).

**Table 5.** Total and Avoidable Food Waste Correlations \* with Disposal Activity, Sociodemographic and Neighbourhood Food Environment Variables.

Variables	Total Food in All Waste Streams	Total Avoidable Food Waste in All Streams	Avoidable Food Waste in Garbage Cart	Avoidable Food Waste in Green Cart
<b>PAYT variables</b>				
Garbage cart set out	0.65 **	0.58 **	0.22	0.59 **
Green cart set out	0.16	0.18	0.19	0.18
Green cart participation	0.19	0.15	0.04	0.19
<b>Sociodemographic and socioeconomic variables</b>				
Median household income	0.56 **	0.46 **	0.00	0.55 **
Population density (average population density within 1km buffer (people per sq. km) (Population density)	−0.62 **	−0.61 **	−0.23	−0.59 **
Dwelling density (average dwellings within 1 km buffer) (dwellings per sq. km) (Dwelling density)	−0.58 **	−0.57 **	−0.23	−0.56 **
<b>Neighbourhood food variables:</b>				
Distance to nearest fast food outlet	0.25	0.17	−0.24	0.29
Average distance to nearest three fast food restaurants	0.53 **	0.46 **	−0.05	0.55 **
Number of fast food outlets within 1 km buffer	−0.52 **	−0.48 **	0.01	−0.55 **
Density of fast food outlets within 1 km buffer (per sq. km)	−0.51 **	−0.47 **	0.04	−0.56 **
<b>Distance to nearest less healthy food outlet</b>				
Average distance to nearest three less healthy food outlets	0.57 **	0.53 **	0.10	0.53 **
Number of less healthy food outlets within 1 km buffer	0.60 **	0.52 **	0.05	0.59 **
Density of less healthy food outlets within 1 km buffer (per sq. km)	−0.49 **	−0.44 *	0.00	−0.48 **
<b>Distance to nearest supermarket</b>				
Average distance to nearest three supermarkets	−0.50 **	−0.44 *	0.03	−0.50 **
Number of supermarkets within 1 km buffer	0.08	0.01	−0.09	−0.01
Density of supermarkets within 1 km buffer (per sq. km)	0.11	0.05	−0.20	0.10
<b>Distance to nearest healthier food outlet</b>				
Average distance to nearest three healthier food outlets	−0.02	0.02	0.23	−0.03
Number of healthier food outlets within 1 km buffer	0.06	0.09	0.25	0.05
Density of healthier food outlets within 1 km buffer (per sq. km)	0.36 *	0.29	0.10	0.22
Number of healthier food outlets within 1 km buffer	0.44 *	0.35	0.02	0.35 *
Density of healthier food outlets within 1 km buffer (per sq. km)	−0.52 **	−0.44 *	−0.00	−0.50 **
Density of healthier food outlets within 1 km buffer (per sq. km)	−0.49 **	−0.41 *	0.017	−0.48 **

\* Correlation is significant at the 0.05 level (2-tailed); \*\* Correlation is significant at the 0.01 level (2-tailed).

The amount of avoidable food in the garbage cart was positively and significantly impacted by green cart set out and the distance to the nearest healthier food outlet. Avoidable food in the garbage cart was also negatively and significantly impacted by the distance to the nearest fast food restaurant and dwelling density. This regression model explained approximately 40% of the variance (Table 6). The amount of avoidable food in the green cart was positively and significantly impacted by green cart set out, median household income and the density of supermarkets within a 1 km radius and negatively and significantly impacted by the density of less healthy food outlets with a 1 km radius. This regression model explained 57% of the variance (Table 6).

**Table 6.** Multiple Linear Regression Analysis of Total and Avoidable Household Food Waste.

	B	SE	$\beta$
<b>Total food waste</b>			
(Constant)	−83.56	70.57	
Garbage set out	5.73	2.45	0.31 *
Green cart participation	6.83	2.93	0.36 *
Dwelling density	−0.02	0.06	−0.40 **
Distance to nearest healthier food outlet	0.12	0.04	0.54 **
Supermarket density (1 km)	34.33	10.90	0.56 **
Model statistics $R^2 = 0.67$ $F(5,26) = 13.51$ , $p < 0.001$			
<b>Avoidable food waste</b>			
(Constant)	−38.60	54.81	
Green cart set out	3.89	1.06	0.51 **
Dwelling density	−0.02	0.01	−0.51 ***
Distance to nearest healthier food outlet	0.10	0.03	0.60 **
Supermarket density (1 km)	27.91	7.97	0.60 **
Model statistics $R^2 = 0.55$ $F(4,27) = 10.36$ , $p < 0.001$			
<b>Avoidable food in the garbage cart</b>			
(Constant)	−5.91	22.97	
Green cart set out	1.92	0.59	0.50 **
Dwelling density	−0.01	0.00	−0.39 *
Distance to nearest fast food restaurant	−0.10	0.02	−0.94 ***
Distance to nearest healthier food outlet	0.06	0.02	0.74 **
Model statistics $R^2 = 0.40$ $F(4,27) = 6.16$ , $p < 0.001$			
<b>Avoidable food in the green cart</b>			
(Constant)	−8.10	26.62	
Green cart set out	2.32	0.65	0.45 **
Median household income	0.13	0.05	0.40*
Supermarket density (1 km)	18.97	4.82	0.61 **
Less healthy food outlet density	−1.80	0.52	−0.63 **
Model statistics $R^2 = 0.57$ $F(4,27) = 11.34$ , $p < 0.001$			

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

Multiple linear regression models were developed for each avoidable food type and the models described a medium to large amount of the variability for bakery ( $R^2 = 0.35$ ), meat and fish ( $R^2 = 0.52$ ), dried food ( $R^2 = 0.37$ ), fruit and vegetables ( $R^2 = 0.31$ ), and other food ( $R^2 = 0.23$ ), but not dairy ( $R^2 = 0.10$ ) (Table 7). For bakery, green cart participation, distance to nearest fast food restaurant and supermarket density had positive and significant impacts on the amount disposed. For meat and fish, garbage set out and median household income had positive and significant impacts, while distance to the nearest healthier food outlet and number of less healthy food outlets with a 1 km buffer had a negative and significant impact on the amount disposed. For dried food, fast food restaurants within a 1 km buffer had a negative and significant impact on the amount disposed. For fruit and vegetables, green cart set out, median household income and supermarket density had positive and significant impacts on the amount disposed. For other food, dwelling density had a negative and significant impact on the amount disposed.

Many of the above noted linear multiple regression models include both neighbourhood food environment and sociodemographic/socioeconomic variables. To help better understand any possible interrelationships of these variables in regression analysis, correlation coefficients were estimated (Table 8). This showed that the higher the dwelling density, the significantly lower the median household income ( $r = -0.50$ ,  $p < 0.01$ ) but the higher the less healthy food outlet density ( $r = 0.63$ ,  $p < 0.01$ ). The higher the median household income, the further the distance to the nearest healthier food outlet ( $r = 0.57$ ,  $p < 0.01$ ), fast food restaurant ( $r = 0.61$ ,  $p < 0.01$ ), and the lower the density of less healthy food outlet density ( $r = -0.63$ ,  $p < 0.01$ ). The higher the supermarket density, the lower the

distance to the nearest healthier food outlets ( $r = -0.60, p < 0.01$ ), fast food outlets ( $r = -0.85, p < 0.01$ ) and the higher the density of less healthy food outlets ( $r = 0.59, p < 0.01$ ).

**Table 7.** Multiple Linear Regression Analysis of Avoidable Food Waste by Household Food Waste Type.

	B	SE	$\beta$
<b>Bakery</b>			
(Constant)	-23.25	7.68	
Green cart participation	0.89	0.26	0.56 **
Distance to nearest fast food restaurant	0.02	0.00	0.94 **
Supermarket density (1 km)	5.78	1.53	1.11 **
Model statistics $R^2 = 0.35$ F(3,28) = 6.56, $p < 0.01$			
<b>Meat and Fish</b>			
(Constant)	-24.99	6.61	
Garbage set out	0.72	0.29	0.33 *
Median household income	10.75	3.47	0.50 **
Distance to nearest healthier food outlet	-0.18	0.01	-0.71 **
Number of less healthy food outlets within 1 km buffer	-0.59	0.13	-0.86 ***
Model statistics $R^2 = 0.52$ F (3,28) = 12.35, $p < 0.001$			
<b>Dried Food</b>			
(Constant)	17.92	1.93	
Fast food restaurants within 1 km buffer	-0.66	0.15	-0.62 ***
Model statistics $R^2 = 0.37$ F (1,30) = 31.39, $p < 0.001$			
<b>Fruit and Vegetables</b>			
(Constant)	-115.32	39.96	
Green cart set out	0.08	0.39	0.32 *
Median household income	24.45	7.05	0.55 **
Supermarket density (1 km)	3.78	1.36	0.45 **
Model statistics $R^2 = 0.31$ F (3,28) = 5.65, $p < 0.01$			
<b>Dairy</b>			
(Constant)	-9.62	5.03	
Green cart set out	0.19	0.10	0.36
Distance to nearest fast food restaurant	0.01	0.01	0.59
Supermarket density (1 km)	1.97	1.08	0.62
Model statistics $R^2 = 0.096$ F (3,28) = 5.55, $p = 0.123$			
<b>Other</b>			
(Constant)	20.02	3.10	
Dwelling density	-0.00	0.00	-0.51 ***
Model statistics $R^2 = 0.232$ F (1,30) = 10.37, $p < 0.01$			

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

**Table 8.** Correlations of Significant (from Multiple Linear Regression Analyses) Sociodemographic/Socioeconomic and Neighbourhood Food Environment Variables.

	Dwelling Density	Median Household Income	Supermarket Density	Distance to Nearest Healthier Food Outlet	Distance to Nearest Fast Food Outlet	Less Healthier Food Outlet Density
Dwelling density	1.00	-0.50 **	0.05	-0.28	-0.31	0.63 **
Median household income	-0.50 **	1.00	-0.23	0.57 **	0.61 **	-0.63 **
Supermarket density	0.050	-0.23	1.00	-0.60 **	-0.85 **	0.59 **
Distance to nearest healthier food outlet	-0.28	0.57 **	-0.60 **	1.00	0.70 **	-0.74 **
Distance to nearest fast food restaurant	-0.31	0.61 **	-0.85 **	0.70 **	1.00	-0.81 **
Less healthy food outlet density	0.63 **	-0.63 **	0.59 **	-0.74 **	-0.81 **	1.00

\*\* Correlation is significant at the 0.01 level (2-tailed).

## 7. Discussion

### 7.1. PAYT and Food Waste Disposal

Key attributes of the PAYT waste program can include source reduction of waste and an increase in waste diversion [20]. These attributes are built on increasing fees based on the amount of garbage disposed. In Toronto, as of 2016, households paid an annual net fee for their garbage carts of: S—\$18.00 CAD for a 75-litre cart; M—\$115.00 CAD for a 120-litre cart; L—\$295.00 CAD for a 240-litre cart; and XL—\$411.00 CAD for a 360-litre cart. The cost/litre of annual disposal capacity is \$0.24 CAD for S garbage carts and \$0.96–\$1.23 CAD for M–XL garbage carts (with L garbage carts being the most expensive).

Households with S garbage carts threw out significantly less total food waste than households with L and XL garbage carts and this was most pronounced in the amount of food waste disposed in the garbage cart, which at 0.29 kg/household/week was significantly less than all other garbage cart sizes. To put this in perspective, households with M garbage carts threw out twice as much, while households with XL garbage carts threw out six times as much food waste in the garbage cart as households with the S garbage cart. Households with M garbage carts disposed significantly less food than households with L and XL garbage carts, the latter of which threw out approximately two and a half and three times as much food waste, respectively. Households with L and XL garbage carts disposed similar and much higher amounts of food waste. Therefore, Hypothesis 1 was supported.

Households with larger garbage carts can dispose of more food waste in them, and clearly, they do. It is important to note that in addition to food waste, the contents of green carts also include sanitary products, pet waste and non-recyclable papers. Their fixed volume means that every household, regardless of their garbage cart size, has the same green cart disposal capacity. This is reflected in the lack of any significant differences in food waste in the green cart.

The amount of any food waste reduction, as a result of this PAYT waste program, is unknown as pre-program measurements were not conducted. However, the quantity of food waste in the garbage stream (i.e., garbage cart) was lowest in this study, when compared to other Ontario municipalities [15,16,18]. The amount of total food waste disposed was similar to Guelph, Ontario, a nearby mid-sized city [18]. Like Toronto, Guelph also has a green cart program. Interestingly, the total quantity of food waste in Toronto and Guelph (that does not have a PAYT waste program) was similar but considerably higher than reported in a study of nine Ontario municipalities [16] and the mid-sized city of London, Ontario [15]. This suggests that Toronto's PAYT waste program has had a limited impact on source reduction of food waste. *It also suggests that households with access to a green cart dispose of more food waste than households without a green cart program.*

Toronto's PAYT waste program does appear to help drive food waste diversion behaviour, as 69.90% of food waste was disposed in the green cart. The capture rate of food waste in the green cart decreased with garbage cart size. Households with S garbage carts put 87.27% of food waste in the green cart while households with XL garbage carts put 55.23% of food waste in the green cart. As noted, 61.78% of food waste was avoidable. Interestingly, avoidable food waste from garbage and green carts comprised 74.95% of food waste from households with S garbage carts (2.41 kg/household/week) but only 44.67% in households with XL garbage carts (2.01 kg/household/week).

Since PAYT waste programs are built on an economic incentive, it is interesting to understand the economic impact of avoidable food wasting behaviours. Using the value of avoidable food waste developed by Von Massow et al. [18] of \$6.04 CAD/kg of avoidable food waste (i.e., \$18.01 CAD/kg food/2.98 kg avoidable food/week), the annual costs of avoidable food wasting ranges from \$630.00 for households with XL garbage carts to \$847.00 CAD for households with M garbage carts. Households with S garbage carts throw out \$758.00 CAD. By throwing out less avoidable food waste, households with XL garbage carts reclaim 37.24% and 52.83% of their annual garbage cart fee, when comparing to the monetary value of avoidable food waste thrown out by households with S and M garbage carts, respectively.

## 7.2. Sociodemographic, Socioeconomic and Neighbourhood Food Environment Variables

Larger households can result in greater waste and food waste disposal [66,67]. In this study, higher dwelling density is associated with less household total and avoidable food waste disposal and this is likely because household size is smaller, and these households generate, and thus dispose of, less food waste.

There was an association with median household income and the amount of total curbside food waste disposal supporting Hypothesis 2. This association also carried through to total avoidable food waste, avoidable food waste in the green cart (Table 5), as well as in regression models for total avoidable food in the green cart (Table 6) and total avoidable meat and fish and fruit and vegetables (Table 7). While it has been shown that higher household income can result in greater waste disposal [68–70], a recent study on avoidable household food waste showed no association with household income [12].

The distance to and density of food outlets also appears to have some association with food waste disposal. In regression models, supermarket density was positively and significantly associated with both the overall total and total avoidable food waste disposal. This did not support Hypothesis 3a. Our initial thinking was that closer proximity to a supermarket could mean more frequent shopping for smaller amounts of food and therefore less food waste, as reported in other studies [57,71,72]. While we did not interview households on their shopping habits, this opinion may be unfounded. It is therefore not immediately clear why supermarket density is associated with more food waste disposal. In a survey on supermarket choice, only one-third of respondents indicated that they shop at the nearest supermarket for their primary source of food [73] and some researchers suggest that supermarket/food store proximity may not be the best variable to determine their access [73–75].

Nonetheless, the impact of supermarket density was further manifested as positive and significant associations with the amount of avoidable fruit and vegetables and bakery items disposed. There is some evidence that proximity to supermarkets and healthier food outlets is positively associated with consumption of fruit and vegetables [49,53] and bakery products [53]. This consumption could be accompanied by collateral avoidable food waste from these relatively perishable food items.

The further distance from healthier food outlets (standalone bakeries, butcher shops, etc.) was positively associated with less food waste disposal and, on the surface, this appears to contradict the association of food wasting and supermarket density. It could be that having to travel further to obtain food results in better matching household food needs with consumption, and therefore less food waste. Similarly, looking at it another way, a lower density of supermarkets is associated with less food waste disposal.

In a recent study, greater supermarket access was associated with less fast food dining [76], and by inference, fewer meals outside of the home, and this could result in more food waste disposal at home. In our study, further distance to the nearest fast food location was associated with less avoidable food waste in the garbage cart; or put another way, households in closer proximity to fast food outlets dispose of more avoidable food waste in their garbage cart and this partially supports Hypothesis 3b. It could be that households with more ready access to fast food eat more meals out of the home and this results in more avoidable food waste generation because what was purchased was not consumed.

This is contradicted somewhat by a higher density of less healthy food outlets (i.e., convenience stores) being associated with less avoidable food waste disposal in the green cart. In this case, it could be because a convenience store may replace supermarket shopping, from time to time, resulting in the purchase of ready-made meals (e.g., frozen entrées) and less purchase of perishable items that could become avoidable food waste.

Future research should endeavor to communicate with households, at (or around) the same time that waste samples are being collected, to better understand their food purchasing, management and disposal habits. Although care was taken in this study to select single-family households that were representative of Toronto, a possible study limitation is that these households may not be fully representative of all single-family households across Toronto, or be generalizable to other cities. Another limitation is that only food waste placed at the curb was examined and this does not account

for any food placed in a home composter, fed to pets or poured down the drain. That said, this research makes important contributions to both the food wasting and food environments literature, as the associations between household food wasting and PAYT programs and neighbourhood food environments have not been identified in previous studies.

## 8. Conclusions

Sample households in Toronto disposed an average of 4.22 kg/household/week of total food waste, with 69.90% disposed in the green cart. In this PAYT waste program, where annual net fees for the S garbage cart are \$18.00 CAD and \$411.00 CAD for the XL garbage cart, households with larger garbage carts disposed more food waste, plateauing at households with L garbage carts, and this was more pronounced in the garbage cart rather than the green cart (i.e., same size for each household). An estimated 61.78% of this food waste is avoidable food waste and it is households with XL garbage carts that dispose of the least amount of avoidable food waste. Avoidable fruit and vegetable waste was the most common food type across all garbage cart sizes and in the green cart. Toronto's PAYT waste program has been effective at diverting food waste into the green cart but not at reducing the amount of food waste generation.

Households with higher median incomes tend to dispose of more food waste and those where household density is higher dispose less food waste. This could be due to greater disposable income to spend on food and household size, respectively. Higher supermarket density was associated with more food waste disposal and there were indications that proximity to fast food and less healthy food outlets was also associated with additional food waste disposal. There were also indications that reduced proximity/density of supermarkets and healthier food outlets were associated with less food waste disposal. This contradicts recent findings which suggest that higher supermarket density (to a point) decreases consumer food waste disposal [57].

These data can be used to help formulate avoidable food waste reduction interventions. In terms of the PAYT waste program, this could be accomplished by re-visiting and potentially increasing garbage cart fees. Alternately, PAYT could be switched to a weight-based approach which has been shown to be more effective at source reduction of waste [22,23]. This could be coupled with messaging to remind households of the value of the avoidable food waste they are disposing of (i.e., \$630.00–\$847.00 CAD/year), as this type of intervention was recently demonstrated as being effective for reducing household food wasting [17]. At the very least, it is prudent to provide households with L and XL garbage carts with larger green carts so that they can divert more of their avoidable food waste to the green cart. In areas with greater supermarket density, the City could work with food retailers and households to improve how households shop for food and help them work towards matching food purchase with its consumption. Reminding households of the above noted annual cost of avoidable food, as well as garbage cart costs, are useful reminders and a potential driver of behavioural change.

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