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## Full length article

## Impact of COVID-19 on household waste flows, diversion and reuse: The case of multi-residential buildings in Toronto, Canada

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## ABSTRACT

The COVID-19 pandemic has had numerous environmental consequences, including impacts on municipal waste management systems. Changes in consumption and waste disposal patterns and behaviours during the lockdown period have produced new challenges for solid waste management and waste diversion activities. This paper develops a conceptual model that reflects short-term changes in waste flows from households that are due to COVID-19 disruptions, focusing on the case of multi-residential buildings in Toronto, Canada. Multi-residential buildings are of interest because they differ from single family homes in several key ways that can produce some slightly different impacts of COVID-19 on waste flows and practices. Primary research for the study included interviews with 19 staff, residents and property managers of ten multi-residential buildings. All of the research took place while Toronto was still in partial-lockdown. Analysis of the interviews revealed five themes around the impact of COVID-19: (1) changes in garbage, recycling and organics flows, (2) new health and safety concerns, (3) changes in reuse and reduction practices, (4) changes in special waste and deposit-return bottle collections, and (5) changes in waste diversion and reduction education. Given the time frame of our study, we recognize these as short-term impacts and call for future research to determine how many of the changes are likely to perpetuate over the medium and longer term.

## 1. Introduction

The COVID-19 pandemic has had numerous consequences for the economy, employment and day-to-day life. Early evidence suggests that it is also having an impact on household waste quantities. Limited US data suggest that declarations of public health states of emergency and lockdowns due to COVID-19 have led to an increase in total municipal waste, across garbage, recycling and organics streams, although some US municipalities paused their diversion programs (Staub, 2020a; Staub, 2020b). In England, a late May 2020 survey of local authorities found that over 90% were reporting higher than usual garbage and recycling while food waste was up 75% (ADEPT, 2020).

The Province of Ontario, Canada, which is the location for the present study, has seen relatively moderate changes in waste stream quantities during the COVID-19 pandemic, at least so far. The lockdown and re-opening in Ontario were phased as shown in Fig. 1. Schools and many types of businesses remain closed as of the time of this study. In the City of Toronto, waste, recycling and organics collection services were not impacted except that residents were advised to no longer put

personal hygiene/sanitary products, tissues, napkins, and paper towels in the organics bin but rather in the garbage. People were encouraged to work at home and only leave when essential, such as for grocery shopping. Outside the home, physical distancing was strongly recommended. It wasn't until the third week of May that mask-wearing was recommended when physical distancing wasn't possible.

Ontario waste data comparing March and April to the previous year's waste data for 12 municipalities show a moderate increase in the collection of garbage (+5%), organics (+8%) and recycling (+2%) tonnages between the beginning of March and mid-April (van der Werf et al., 2020). Some of the change is tempered by the fact that municipalities often collect from small retail establishments for a fee and do not separate out this data from the residential data. Hence, changes in household waste may be somewhat higher. Breaking down the data over time, van der Werf et al. (2020) find that the largest increase for all three waste streams across municipalities occurred during the first week of the lockdown and declined thereafter, reaching parity with the previous year's numbers by the middle of April.

None of the available data on changes in waste arisings

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Fig. 1. Toronto Covid-19 lockdown and partial-opening timeline to end of May 2020.

differentiates changes for households in single family homes from households in multi-residential dwellings. However, the two dwelling types are known to differ in their waste diversion rates and the underlying factors that contribute to that difference may produce differences in the impact of COVID-19 as well. In the City of Toronto, for example, residents of single-family homes diverted 64% of their waste from landfill in 2019 while residents of multi-residential buildings diverted only 28% (City of Toronto, 2020). The existence of a disparity in diversion rates between the two types of housing is typical of urban areas in North America and Europe (Lakhan, 2016).

Research into factors that contribute to low levels of waste diversion in multi-residential buildings has highlighted, amongst others, that waste diversion is less convenient in multi-residential buildings because residents typically have to get in an elevator to take their recyclables and organics outside or to the basement of the building (DiGiacomo et al., 2017; Lakhan, 2016; Rousta et al., 2015; Ando and Gosselin, 2005). Garbage disposal is typically much more convenient, with a garbage chute on each floor, although many new buildings now include chutes for multiple waste streams. Multi-residential units also have limited storage space for in-home recycling and organics bins (Ando and Gosselin, 2005).

COVID-19 could further undermine convenience in multi-residential buildings since physical distancing in an elevator is difficult. It brings to the foreground what Ho (2018) refers to as the social dimension of convenience, where convenience of diversion is affected not only by proximity to the building's waste diversion site but also by uncomfortable social encounters experienced in getting there. Space constraints in units may make it difficult for households to store items, such as old office furniture, that they would like to take to second-hand stores. Instead they may leave them for garbage collection. One area where convenience can be higher for multi-residential compared to single family homes is in diversion of clothing, special waste, such as e-waste, and reusable items. Facilities for their collection can be located on-site because of the highly localized supply, rather than off-site as for single family homes (Ordonez et al., 2015). However, if those services are suspended during COVID-19, the items will be more likely to end up in the garbage. Both convenience and storage factors suggest that garbage in multi-residential homes could be higher than in single family homes during a lockdown.

There has been very little scholarly research to date on the impact of COVID-19 on household waste behaviour and none that we are aware of for multi-residential waste. Given the absence of scholarly literature, we will employ primary research in the form of semi-structured interviews with staff, property managers and residents of a sample of multi-residential buildings to understand the impact of COVID-19 on garbage, recycling, organics and reuse in those buildings. Using this information, we will then develop a conceptual model of the impact of COVID-19 on multi-residential waste.

## 2. Methods

The work presented in this article is based on 15 individual interviews and two focus group interviews with two people each, all conducted by videocalls, for a total of 19 participants from ten residential high-rise buildings in the City of Toronto, Ontario, Canada. Most

buildings had two interviews but one had three and two had only one. All but three of the interviews took place during the third and fourth weeks of May. The three additional interviews were conducted during the last two weeks of July in order to expand the sample size and came from the buildings designated as B9 and B10 in the results section. The study participants included seven residents, nine staff (superintendents and cleaners), and three property managers. The ten buildings were recruited through the Zero Waste High Rise (ZWHR) project, which is led by an NGO, the Toronto Environmental Alliance (TEA), in partnership with the University of Toronto. TEA has been working with multi-residential buildings across Toronto since 2018 to help them reduce waste and increase recycling and organics diversion. Eight of the buildings were recruited as project buildings that received a waste audit as well as coaching to develop and carry out a waste reduction plan and opportunities to participate in peer learning. The waste reduction plans have typically included education initiatives and the introduction of new waste reduction facilities or services. Two of the buildings were considered 'model' buildings in the project, with high diversion rates and low per-unit garbage volumes.

Since the buildings recruited for the current research were part of the ZWHR project, they were committed to improved waste diversion prior to the COVID-19 pandemic and they have waste diversion services and facilities that may be uncommon in other multi-residential buildings. Together, the ten buildings demonstrate a range of diversion rates and garbage volumes with pre-COVID diversion highest (66%) in one of the model buildings and lowest (20%) in one of the project buildings.

The interviews followed a semi-structured format and lasted 15 to 30 min. Staff were asked to estimate changes in the volume and composition of individual waste streams since the beginning of the lockdown and assess the perceived impacts of physical distancing on their work and waste diversion in their building. The residents who were interviewed were all part of committees in their building that were involved in building initiatives to improve waste diversion. They were asked about suspended waste diversion activities due to the pandemic, the impacts of physical distancing measures on waste diversion, changes in the messaging to residents and their opinions and observations on how other residents were responding to these changes. The property managers were asked a combination of the questions that were directed to the staff and residents. All participants are identified by their building code names (B1 to B10) in the results section.

The thematic analysis of the interviews was an iterative process, including meetings of the research team to deliberate the potential themes and linkages between those themes. The interview transcripts were coded using NVivo 12, arranged in themes by one researcher, and then independently checked by a second researcher on the team. Themes were refined continuously through this investigator triangulation process, differentiating main themes and reaching consensus over diverging items through discussion. The additional interviews conducted in July did not add any new themes to the analysis but rather confirmed those that had been identified already. We judged that the interviews had reached what is known in qualitative research as the point of saturation (Given, 2016). Quotations were selected from the interviews to represent common views about a specific theme.

The buildings that participated in the study included seven co-operative housing buildings and three condominiums, with an average of

around 170 units (see Appendix). Seven buildings in the study have mixed demographics, including families, young couples, and seniors, two of the buildings are seniors-only or mostly senior residents (B7, B8), and one is mostly singles and couples (B6). The cooperative housing buildings have 10–60% subsidized units. The buildings have similar characteristics in their set-up of the main waste streams, garbage, recycling, and organics, as well as the additional diversion services that they provide. Buildings B1 to B7, B9 and B10 all have garbage chutes on each floor, while B8 has an organics chute instead of a garbage chute. One building has a small recycling bin (B1) on each floor and one has a larger recycling cart in the chute room. The rest have recycling bins on the ground floor or basement. All but one of the buildings provide a range of services for special waste collection, including electronic waste, batteries and household hazardous waste, as well as collection or sharing sites for reusable items such as clothing, books, and other household items.

A limitation of the sample for this study is that it includes only two types of housing tenure, which could affect representativeness of the findings. In particular, it includes only cooperative housing and condominiums where unit ownership is the norm rather than buildings that are primarily rental. Since those who own their home tend to recycle more than renters (Geiger et al., 2019) a lockdown might affect recycling practices and pathways in rental buildings differently. The sample also excludes buildings that have tri-sorter chutes, multiple chutes, or no chute at all. Another limitation of the study is the use of interview data to estimate changes in waste streams. The estimates are based on professional judgement rather than measured quantities and cannot account for year-over-year changes for the 11-week period between the beginning of the lockdown and the time of the interviews in May.

## 2.1. Results and discussion

The analysis of interviews identified five themes around the impact of COVID-19: (1) changes in garbage, recycling and organics flows, (2) new health and safety concerns, (3) changes in reuse and reduction practices, (4) changes in special waste and deposit-return bottle collections, and (5) changes in waste diversion and reduction education. Each of these are described below with representative quotes used to illustrate key findings.

### 2.2. Impact on garbage, recycling and organics flows

When asked whether there had been changes in garbage, recycling and organics flows in their buildings, respondents from eight of the ten buildings were able to answer the question for all three streams. In one of the other buildings, the only person available for an interview in B6 was a resident and he was unable to say whether waste streams had changed, except for the organics bin, which he felt was fuller than usual when disposing of organics. Similarly, the only interview for B10 was a resident and she didn't know whether waste volumes had changed. All other interview participants providing waste estimates were staff or property managers and made their assessment of changes based on the number of bins or carts that they recalled setting out themselves or knew were being set out for collection each week.

As illustrated in Table 1, the perceived impact of COVID-19 on

**Table 1**  
Perceived changes in waste volumes since the beginning of COVID-19 lockdown.

Waste Stream	Up	Down	No Change	Unable to Say
Garbage	B1/B3/B8/B9	B4	B2/B5/B7	B6/B10
Recycling	B1/B3/B8	B4	B2/B5/B7/B9	B6/B10
Organics	B1/B6	B3	B2/B4/B5/B7/B8/B9	B10

building waste volumes has been quite variable. For organics, the most common response was no change in the amount collected. This is rather surprising. One might expect that increased eating at home during COVID-19 would increase food waste. However, other factors have been shown to influence food waste during the pandemic and can lead to decreases. In other words, the two effects may be counteracting each other.

One possible reason for increases in food waste, other than more eating at home, is changes in food shopping habits. In a study of shopping habits by Moroccan households during COVID-19, Ouhssine et al. (2020) found that households decreased their frequency of shopping after lockdown, with the percentage of households shopping more than once per week declining from 70% to 45%. Similarly, Jribi et al., 2020 found that Tunisian households decreased their frequency of shopping during lockdown. This change in habit is important because some evidence suggests that less frequent shopping can increase food waste (Giordano et al., 2019). However, several other studies have found no relationship with frequency of shopping (Koivupuro et al., 2012; Silvennoinen et al., 2014; Qusted and Luzecka, 2014).

Evidence about decreases in food waste during COVID-19 comes from one national and one international study. In a survey of US households ( $n = 1005$ ) in April 2020, HUNTER (2020) found that not only were households cooking at home 54% more than before COVID-19 – which would suggest more food waste – but 57% also reported that they were wasting less food, which suggests that the net effect could amount to no or little change in the organic waste stream. As reported in Reuters (2020), Charlotte De Backer and colleagues at the University of Antwerp conducted a multi-country household survey ( $n = 6000+$ ) on eating and cooking behaviours during COVID-19. Their study, as yet unpublished, found that households use up leftovers more during COVID-19, which research has shown, not surprisingly, leads to less food waste (Qusted and Luzecka, 2014).

We are not aware of any studies on the impact of COVID-19 on recycling, but one would expect that if households are relying more on online shopping, then that would increase the amount of packaging waste in the home and hence the amount of recycling. On the other hand, physical distancing and avoidance of surface touching might be incentives to use the garbage chutes more for disposing of waste rather than carrying household recycling and organics to bins on the ground floor or basement of a building. If that is so, then buildings should be seeing a rise in garbage volumes. However, as shown in Table 1, half of the buildings in this study experienced either no change in garbage volumes or a decrease.

Two of the three buildings that saw no change in any of their waste streams were mostly seniors or all seniors buildings (B5, B7). A staff member in one of them commented that since none of the residents were working and were used to staying at home, COVID-19 had little impact on their wasting practices. For the third building that had no change in garbage (B2), there was a discrepancy between the lack of change reported by the staff member and the perception of increased waste expressed by a resident:

B2 Resident: Oh, yeah. Everybody is creating more waste of all types. I can tell but people also comment on it. People are like, 'We can't believe how much waste we're creating'... It's the kind of waste that they probably would have but it would have been at the office or out of the house.

As people are working from home, and children not attending school, much waste generation has shifted from offices and schools to residential buildings.

A third mostly seniors building (B8) had a slight increase in garbage and a more substantial increase in recycling that was due to more cardboard boxes in the recycling bins that had not been broken down. Increased cardboard packaging from deliveries was also mentioned in most other buildings. Unable to visit stores and restaurants, people have

increased their reliance on online shopping and ordering food for delivery, thus increasing their cardboard packaging waste.

B8 Staff: I mean, Amazon Prime must be here fifty times a day. And couriers and everything else. So, there's a lot more cardboard boxes and things like that.

A staff member from building B4, which had increased recycling, commented that he was seeing more contamination in the recycling bins, which could account for a small amount of the increase.

B4 Staff: People are gardening and they're contaminating the recycling by throwing in soil-soaked cardboard and plastics and they're just dirty stuff. And I extract that and throw it in the garbage but, you know, they... a lot of people are at home because of the state of emergency.

Building B8 has an organics chute and one might expect an increase in the volume of organic waste being set out for collection if residents were avoiding elevators and using the organics chute to dispose of garbage and recycling. However, the building staff member claimed that there had been no change in organics.

Although half of the buildings reported no change in organics volumes, it is possible that an increase in food waste is being hidden by the City of Toronto's requirement that soiled tissues, paper towels and personal hygiene/sanitary products, which were formerly disposed of in organics bins, be shifted to disposal in garbage for health and safety reasons during COVID-19. In the only building where organics was found to be down (B3), the staff member felt that it was due to organics being incorrectly disposed:

B3 Staff: "I don't know why but the organics is really being diverted down to the garbage. And, so we're at a point right now, we're putting out the least amount of organics I've ever seen".

This could also be an example of the physical distancing effect, where people are using the garbage chute for disposal of organics rather than using the elevators and carrying organics down to the basement. In a similar case, a staff member in the only building with an organics chute reported that he had noticed a lot of contamination in organics, perhaps because some residents were using the organics chute for garbage and recycling.

It is not clear why only one building (B1) reported the expected increase in all three waste streams and only two (B3, B8) saw an increase in both garbage and recycling. A possible explanation could have to do with their size. These three are the largest buildings in the group surveyed (except for B6, the building with two missing entries in Table 1) with 206, 180 and 210 units, respectively. It could be that small changes by a large number of residents could result in a noticeable change in the waste stream quantities, unlike small changes by a smaller number of people. One reason why the other buildings did not report increases could be that the changes in quantity provided here are based on estimates, not hard data. A 'small increase' for one building could be judged as a 'dramatic' increase in another building and most participants did not say whether there were changes in the fullness of containers that were set out, just the number that were set out.

It is also not clear why one building (B4) saw both garbage and recycling decrease. This is the building with the lowest diversion rate (20%) in combination with one of the two highest garbage volumes. Since it does poorly on diversion performance, one might expect that recycling would decline even more during COVID-19 when physical distancing might be a further disincentive for recycling, but that does not explain the decrease in garbage quantity. Possibly the factors that produce increases in garbage are being outbalanced in this building by factors that can lead to decreases during COVID-19. For example, with more people unemployed during the pandemic, they have less purchasing power and may decide to reduce overall consumption, which might lead to less waste. A panel-based national survey found that over 60% of Canadians were delaying purchases or services at the end of

March, and that number was still relatively high at the end of May at 50% (Numerator, 2020).

One type of garbage that has clearly increased during COVID-19 is personal protective equipment (PPE) – masks and gloves. The City of Toronto requires that all used masks and gloves be disposed of in the garbage. However, these are items that households have not had experience managing previously and there may be lack of knowledge about where to dispose of them without extensive education. Gloves are plastic and most plastics are accepted by the City's recycling program, while disposable masks appear similar to sanitary products that are permitted in the organics bins. Predictably, participants from several buildings in the study have reported contamination of both recycling and organics from PPE and contamination of organics by soiled tissues, paper towels and personal hygiene/sanitary products. In one building, the staff have been emptying the contents of the recycling bin located in their parking lot into the garbage since residents "throw away even gloves there and napkins. So, the recycling is totally contaminated". Buildings are seeing this type of contamination despite their best efforts to educate residents about the new items and the change in sorting procedures.

The definition of contamination in the organics stream changed overnight when the City said that soiled tissues, paper towels and personal hygiene/sanitary products were no longer allowed in the organics stream. This came after years of public education about the organics stream being the proper place for disposal of these three items, which, unlike food waste, are not easily identified as belonging in an organics stream. The City even accepts diapers in the organics stream. Not all municipalities accept sanitary products or diapers in their organics bins but Toronto has an anaerobic digester facility that can manage them. That three items previously accepted in the organics stream were now considered garbage is an example of how waste as a category is socially constructed rather than self-evident (Gregson and Crang, 2010). A sudden pivot on the meaning of waste is also very confusing for residents and it is not unexpected that staff are seeing contamination problems. Adding to the confusion, the City's directive excluded personal hygiene/sanitary products from the organics stream but not diapers.

### 2.3. New health and safety concerns

COVID-19 has created new health and safety concerns for residents of multi-residential buildings. While governments worldwide are calling on their citizens to practice physical distancing, the high-density living spaces of multi-residential buildings make compliance with calls for physical distancing challenging. The multi-residential buildings included in this study promoted physical distancing by posting physical distancing messages and recommending restrictions on elevator occupancy. The staff and residents that we spoke to had different views on the impact of physical distancing on the building's waste diversion performance. Some residents and staff believe that the physical distancing measures implemented in their building, such as having "one [person] per elevator unless it's someone that you reside with", allowed residents to be comfortable in accessing and using common areas to dispose of recycling and organics.

B6 Resident: With the restrictions to the elevator, we haven't had any issues going up and down, like trying to keep social distancing from others. I don't think people would be discouraged unless they have their own personal fears and concerns.

In another building (B1), a staff member noted that the initial fears about COVID-19 may have produced a high level of compliance with physical distancing in elevators at the beginning of the lockdown, but over time, those fears wore off and after two to three weeks, he observed three or four people using the elevator at the same time. This speaks to the question of short, medium and long-term behaviour changes arising from COVID-19 that will be touched on later.

According to a staff member in one building, the different times that people come down to dispose of waste have made physical distancing less of a challenge. This staff member came from a building where the recycling bins are outside rather than on each floor. The time separation could be due to the fact that few people are leaving for work in the morning, a time when they might typically take their recycling with them to the outdoor recycling bins, and instead are taking it down at various times during the day.

Several respondents identified fear of surface-touching as having an impact on building waste diversion:

B2 Resident: And like touching even, like our recycling and our compost are more difficult to work than our garbage bin. So, I think it's like having to touch all those bins and separating everything. And they are all in different areas, so like walking through the co-op. I think it's the safety piece.

All buildings in this study require some form of contact with doors or chutes for disposal of garbage, recycling and organics. While doors to chute rooms or waste rooms in some buildings may have automatic door openers, and some buildings have propped open bin lids, most have chute handles and bin lids that require contact with high-touch surfaces that are being wiped down more frequently than usual but not after every use. Although recent communications by the US Centre for Disease Control state that transmission of the COVID-19 virus from touching surfaces is possible, it is not thought to be the main transmission vector, which is person-to-person (Centre for Disease Control, 2020). CDC still recommends regular cleaning and disinfection of frequently-touched surfaces.

#### 2.4. Impact on reuse and reduction practices

Health and safety concerns around surface touching during the COVID-19 lockdown have had significant implications, almost all negative, for reuse and reduction practices. Two residents who pursue a low-waste lifestyle complained that their efforts to reduce or eliminate packaging were on hold. One said that the grocery stores she normally uses no longer accept reusable containers from customers. During COVID-19, retail stores have shifted away from reusable container and cup options that they had introduced relatively recently and back to single use containers (Vann, 2020). Kalina and Tilley (2020) affirm how COVID-19 has led to a widespread resurgence in the use of single-use products and wonder whether this shift can be reversed. A third resident was dismayed her grocery store was using extra packaging to reduce handling of produce:

B9 Resident: I have found mushrooms - usually just they are in bulk and you can pick them up. Some places are putting them in black plastic containers, and even the black plastic cannot be recycled.

Another participant mentioned her household's significant increase in packaging from online ordering for goods and meals. Online ordering in Canada during COVID-19 is up substantially, by 30% at the end of March to 45% at the end of May, according to one online panel-based poll (Numerator, 2020).

The opportunity to reduce waste when grocery shopping in-person by bringing reusable bags has also changed, albeit with mixed messaging. A major grocery chain in Canada has dropped its 5-cent charge for plastic bags in order to discourage use of reusable bags, some stores in that chain only allow plastic bags, and another chain continues to allow reusable bags as long as the customer does the packing (Colbert, 2020). One provincial Ministry of Health in Canada has asked that grocery shoppers not use reusable bags while another announced that there is no risk in using reusable bags (Colbert, 2020). To further encourage plastic bag use, plastic bag bans across the United States and Canada are being suspended or postponed during COVID-19 (Chua, 2020; Martell, 2020).

With online grocery deliveries also on the rise due to safety concerns

with in-person shopping, one respondent noted that people sometimes receive 'substitutes' in their order that they cannot use and residents in her building have started posting and trading food items that they don't like or don't think they will use in time, in order to reduce food waste:

B2 Resident. I ended up getting a squash out of somebody. [laughing] Like I traded carrots for a squash from someone. Oh, yeah, cuz they were allergic to butternut squash.

This is an example of where COVID-19 is stimulating a waste-reducing initiative instead of creating more waste, but whether food trading will cease when households shift back partly or entirely to in-person shopping after COVID-19 is unknown.

The COVID-19 lockdown is also increasing consumption of new items at the expense of used items because used-item stores are closed and typically don't have an online presence. As one resident noted,

B2 Resident: I saw a friend of mine posting that her kids are out-growing clothes and none of the second hand stores are open... .. But I hear a lot of people saying that, things that they rather get in another way, they're having to do online shopping for, because there is just no other option, right?

The COVID-19 pandemic has forced most people to spend more time at home. This has often necessitated changes to create home office workspaces, or places for students and children out of school. Several participants noted that this extra time has also given residents an opportunity to do "spring cleaning":

B9 Staff: Because now they are home, they are like, 'Ok, what do I do? Oh, I'm gonna go throw all my clothes and throw away what's not good anymore.' 'Oh, I'm gonna go through my whole kitchen and throw away what's not good anymore.' And so on. That's what I think because I would find garbage, let's say full of bathroom products and kitchen products that were expired and things of that nature.

A resident from B1 reported that the bulk drop-off area in their waste room "was really getting out of control" with people ridding themselves of old furniture and other large household items. Many spring-cleaning items would normally be donated, but during this period of COVID-19, all the charities and organizations that accept donations had suspended their operations.

Several of the respondents that were interviewed live in buildings that have a clothing and/or a household goods donation bin on site, which has been closed since the beginning of the lockdown. Residents have been asked to hold on to their items. Additionally, five of the buildings have reuse rooms or shelves, that allow residents to leave and exchange items they no longer need. These have now been closed due to concerns about touching items handled by others.

One of the buildings also has a textile waste diversion bin for clothes and other textiles that are not in a reusable condition and cannot be donated but are rather sent for recycling or to be turned into wiping rags. A resident from this building communicated disappointment that the bins had been closed:

B8 Resident: So, that's been really disappointing to me personally, and I think probably to everybody because you've got all this stuff that you'd like to donate, either to a waste diversion bin or to a charitable organization, and you can't complete the task.

Some people just ignored the suspensions. In one building, a resident reported that people were still leaving reusable items at the entrance of the room where the sharing shelf, the 'Free Boutique', used to be. In all buildings, many residents appeared to be storing reusable items at home while others overcame the suspensions by looking for disposal pathways. In three buildings, we heard that the suspensions led to an increase in reusable items ending up in the garbage.

B8 Resident: So, you know, I'd hate to think, there's probably, I hate

to say, some people who said, 'Well, forget it. I'm just gonna put it in the garbage. I want it out of here', rather than hanging on to it. They've been asked to hang on to it, but we all know human nature, if I'm gonna clear out, I want it out, out. So, I suspect that some of that intention for donation has gone into the garbage route and therefore the landfill, instead of donation all because of COVID.

The garbage was not the only destination for reusable items. After closure of the reuse-it table in one building, some residents resorted to 'wishcycling', sending their reusable items to the recycling bins instead.

B5 Resident: We were all locked in our apartments and it's spring-time, and what do you do? You clean up your house. So, they find things that would be of use to other people ... And what was happening was they throw in recycling. They think, 'Oh, this is a nice toy. Somebody might use it.' Well, recycling is not the place for it. It has to go to a charity or the garbage, that kind of a thing.

Other activities that promote reuse have also been suspended in several buildings. In one building, these include a Repair Café event, where residents help each other to mend their damaged items to discourage disposal, a tool share library that aims to promote a sharing economy, and a book collection program that sends books to prisons. In another building, the Outreach Committee organizes a clothing donation drive several times a year, which has also been cancelled.

### 2.5. Impact on special waste collection and deposit-returns

Buildings have reported very little impact of COVID-19 on collection of special waste such as light bulbs, electronic waste, batteries and other household hazardous wastes. These items are simply accumulating at their collection point in the buildings. The City of Toronto's "Toxic Taxi" service that building staff can call for collection of large quantities of special waste was suspended briefly at the beginning of the lockdown but then resumed. One building that collects cooking oil experienced an increase in cooking oil drop-offs, perhaps an indication of increased home cooking during the pandemic.

The Province of Ontario's only deposit-return program experienced a short-term disruption, with implications for household waste. Ontario has a deposit-return program for liquor and beer bottles and cans (but not for any other kinds of bottles or cans). Six of the buildings have a collection site for beer and liquor bottles and volunteers redeem the deposits to fund community events. The province's bottle return program was suspended during the first few weeks of the pandemic but opened shortly after once workplace safety improvements had been made at the return stores. During the suspension, one participant remarked how his building ran out of storage space for the bottles and residents instead had the choice to store them in their units or put the bottles in the recycling bins or garbage. When the suspension was lifted, a volunteer took the bottles and cans to the return store but the building's collection site remained closed at the time of the interviews since there were so many bottles still in storage. It is not known whether the collection service has resumed at other buildings.

### 2.6. Impact on waste diversion and reduction education

Physical distancing requirements have meant that in-person meetings and events to promote waste reduction and diversion in the building have not been possible. Several buildings attempted to engage residents online, but with a relatively low turnout.

B3 Resident: We tried to have a virtual meeting, a webinar. Unfortunately, we couldn't reach as many people as we could in a general members' meeting. I think we had 15–17 people overall, but that didn't really get that message across.

In another building, the annual barbecue was coming up, which would usually have had a booth to educate residents on sorting

practices, as well as a "recycling challenge", where residents would challenge themselves to sort waste. However, the resident from this building remarked that "any of that type of outreach is off the table.". Another resident noted the cancellation of their lobby display.

Participants saw the need to be cautious in resuming and promoting their suspended programs, taking into account building governance:

B6 Resident: ...when things do start to open up, we would like to still continue our shared table, but I think initially we may have to hold off on it until everyone's on board. I think we would have to, you know, have some input from the Board and our management before going back to normal.

Another resident claimed that now was not the right time to deliver a new waste diversion education program since "...right now people are more concerned about keeping themselves safe and looking after their children and just surviving every day" (B8 Resident). However, participants expressed enthusiasm about restarting their education programs when the time comes and continuing to explore new waste diversion and reuse initiatives for their buildings.

Several of the participants were concerned about new, more wasteful practices and 'sloppy' sorting habits having formed during the lockdown. For example, one resident felt that it was going to be challenging to change organics sorting behaviour back to what it was before Toronto's COVID-19 directive came into effect about shifting certain items from the organics stream to garbage:

B8 Resident. We just had everybody trained! And doing the right thing, and now that's all sort of been undone and I think it will take us a little while to get things back on track.

### 2.7. A conceptual model of COVID-19 impacts on multi-residential waste flows

Based on the findings from interviews and relevant literature, we have developed a conceptual model (Fig. 2) of multi-residential waste flows showing how COVID-19 and the lockdown is affecting consumption, disposal and certain waste reuse services offered in multi-residential buildings. The boxes on the left represent specific items, activities or circumstances that have been affected by COVID-19 and the plus and minus signs indicate whether those are leading to more or less waste. The light dashed lines show what kind of waste is being produced. The dotted lines illustrate how the pandemic is introducing new pathways that are contaminating the recycling and organics bins. Finally, the heavy dashed lines are COVID-avoidance disposal pathways, arising from concerns about the inability to physically distance and avoid touching surfaces when using recycling or organics bins.

## 3. Conclusion

This study has identified multiple ways in which COVID-19 and the associated lockdown have impacted waste flows in multi-residential buildings. One of the key findings is that the pandemic has disrupted practices that were moving buildings towards higher levels of waste diversion. Many studies have examined the long-term impact of interventions designed to shift households towards more sustainable behaviour. Often the result is that after a certain period, behaviour change achieved with the intervention returns to the original less sustainable behaviour (e.g. Wemyss et al., 2019). In other studies, behaviour change has been sustained (e.g. Staats et al., 2004). We are not aware of any studies that have examined whether an intervention that leads to less sustainable behaviour, such as reduced waste diversion, will return to the more sustainable pre-intervention behaviour over time. The impact of COVID-19 on waste diversion can be viewed as a natural experiment to assess whether a return to more sustainable behaviour is automatic once the effects of the intervention have been removed, or whether new interventions are needed to shift behaviour back to the

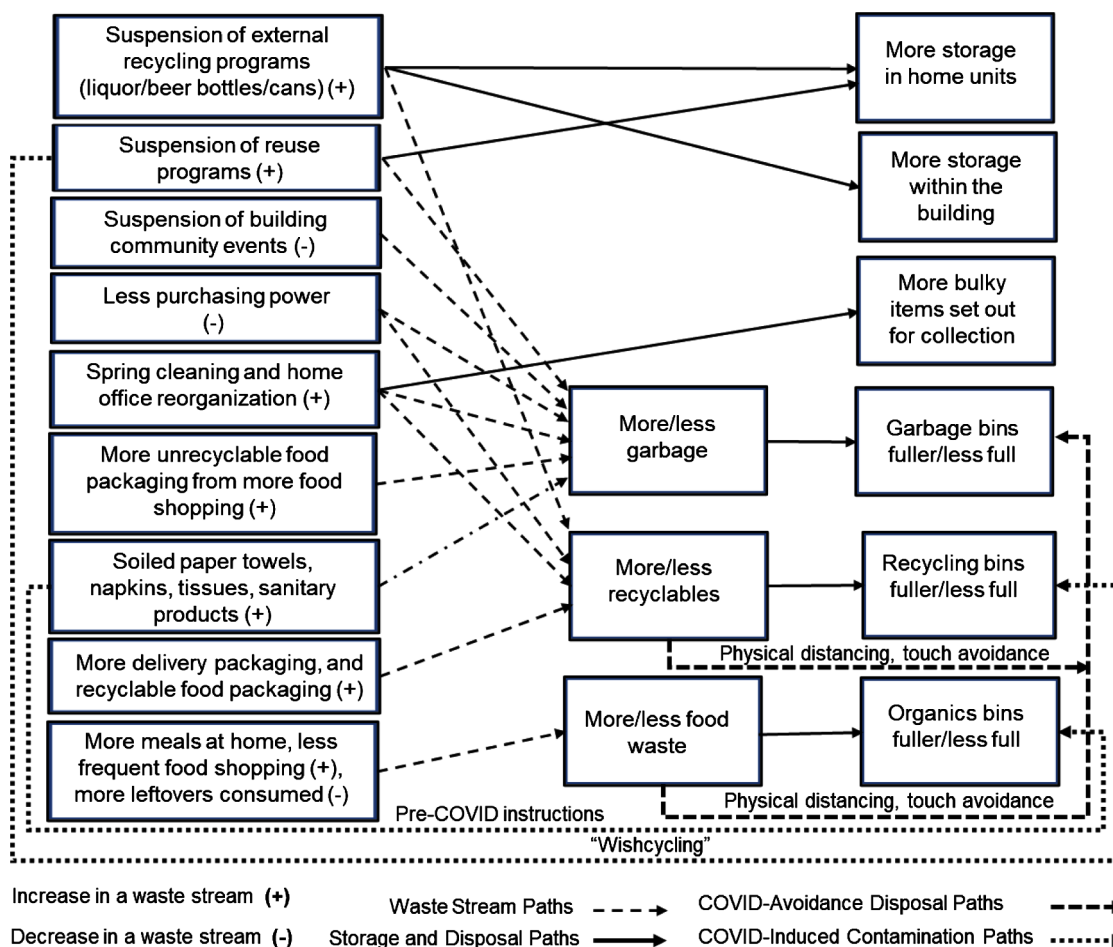


Fig. 2. Covid-19 impacts on multi-residential waste flows.

sustainable practices.

COVID-19 has had unprecedented impacts on all facets of the global society. Given the urgency of the environmental crisis, it is crucial to pay attention to how the pandemic has impacted sustainability goals, including improved waste practices. This paper has highlighted its influence on household waste with a focus on multi-residential buildings. Although long-term changes are currently unknown, observing the initial short-term changes will provide insights for researchers and policymakers in any attempts to reverse adverse impacts, as well as prepare for future shocks to minimize negative changes to waste diversion practices.

**CRedit authorship contribution statement**

**Ece Ikiz:** Conceptualization, Investigation, Formal analysis, Writing - original draft. **Virginia W. Maclaren:** Conceptualization, Methodology, Writing - original draft, Visualization, Funding acquisition. **Emily Alfred:** Conceptualization, Methodology, Writing - review

**Appendix. Building Characteristics Table**

Building Codes	Type	Number of Units	Demographics	Building Diversion	Garbage volume (yd3/unit/month)	Waste, Recycling and Organics Locations	Convenience Services	Special Waste	Reuse Facilities
B1	Co-op	206	Mix of young families, seniors, singles and couples.	45% (medium)	0.28 (medium)	Garbage chute on each floor. Organics and	Small recycling bins on each floor. Small organics cart in the waste room for accessibility.	EW, LB, B, HHW, DB, M	Clothing donation bin. Clothing drive events.

& editing, Funding acquisition. **Sayan Sivanesan:** Conceptualization, Investigation.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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B2	Co-op	101	50% units subsidized. Mix of young families, seniors, singles and couples. 30% units subsidized	30% (low)	0.93 (high)	recycling in the basement waste room. Garbage chute on each floor. Outdoor organics and recycling bins.	Small recycling bin in the waste room for accessibility. Recycling bin in the lobby.	EW, LB, B, M	Reuse-it shelf. Book sharing library. Clothing donation bin.
B3	Co-op	181	Mix of young families, seniors, singles and couples. 20% subsidized units.	48% (medium)	0.31 (medium)	Garbage chute on each floor. Recycling bins in the basement. Organics chute and recycling chute on ground floor.		EW, LB, B, HHW, DB, M	Tool sharing library. Repair Café. Book sharing library.
B4	Co-op	108	Mostly families. Around 20% subsidized units.	20% (low)	0.74 (high)	Garbage chute on each floor. Organics chute on the ground floor. Outdoor recycling bin.		EW, LB, B, DB, M	Reuse-it shelf. Clothing donation bin.
B5	Condo	140	Many seniors, singles and couples; few children; est. less than 20% renters.	54% (medium)	0.28 (medium)	Garbage chute on each floor. Organics and recycling bins on the ground floor.		EW, LB, B, HHW, DB, CO	Reuse-it table. Clothing and household goods donation bin.
B6	Condo	490	Many singles and couples, few children (est. 5% units have children); est. 20% renters.	40% (medium)	0.25 (medium)	Garbage chute on each floor. Organics and recycling bins on the ground floor.		EW, LB, B, HHW, DB, M	Clothing and household goods donation bin. Book sharing library. Reuse-it table 'Free Boutique'.
B7 (model)	Co-op	140	Seniors only, many with mobility limitations or disabilities. 60% subsidized units.	49% (medium)	0.16 (low)	Garbage chute on each floor. Outdoor recycling bin.	Recycling carts in each floor chute room. Organic carts in each floor chute room.	EW, LB, B, DB, M	Book sharing library. Donation drive events.
B8 (model)	Condo	210	Mostly seniors. Mix of families, many couples and singles; some children	66% (high)	0.13 (low)	Outdoor garbage bins. Outdoor recycling bins. Organics chute on each floor.		EW, LB, B, HHW, CO, P, M	Clothing and household goods donation bin. Textile waste bin. Book sharing library. Reuse-it shelf.
B9	Co-op	102	Mixed demographics.	25% (low)	0.44 (medium)	Garbage chute on each floor. Outdoor organics bins. Outdoor recycling bins.		LB, B, HHW, CO, P, DB, M	Clothing and household goods donation bin. Book exchange.
B10	Co-op	134	Mix of young families, singles and couples. 50% subsidized units.	35% (low)	0.50 (medium)	Garbage chute on each floor. Outdoor organics bins. Outdoor recycling bins.	Door-to-door collection of recycling for seniors and residents with mobility issues.	M	None.

Special Waste Codes: EW Electronic Waste; LB CFL/tube light bulbs; B Batteries; HHW Household Hazardous Waste; CO Cooking Oil; P Pharmaceuticals; DB Deposit Bottles; M Bulky/Scrap Metal

## References

- ADEPT (2020) COVID 19 – Waste Survey Results, Week Commencing 18th May. <https://www.adeptnet.org.uk/documents/covid-19-waste-survey-results-wc-18th-may>.
- Ando, A.W., Gosselin, A.Y., 2005. Recycling in multifamily dwellings: does convenience matter? *Econ. Inq.* 43 (2), 426–438.
- Centre for Disease Control (2020) How Covid-19 spreads. <https://www.cdc.gov/coronavirus/2019ncov/prevent-getting-sick/how-covid-spreads.html>.
- Chua, J., 2020. Plastic bags were finally being banned. Then came the pandemic. *Vox* May 20 2020. <https://www.vox.com/the-goods/2020/5/20/21254630/plastic-bags-single-use-cups-coronavirus-covid19-delivery-recycling>.
- Colbert, Y., 2020. Should You Use A Reusable Shopping Bag? Government, Stores Have Different Answers. *CBC News* April 2 2020, <https://www.cbc.ca/news/canada/nova-scotia/reusable-shopping-bag-covid-191.5518765> Accessed June 1 2020.
- DiGiacomo, A., Wu, D., Lenkic, P., Fraser, B., Zhao, J., Kingstone, A., 2017. Convenience improves composting and recycling rates in high-density residential buildings. *J. Environ. Plann. Manage.* 1–23. <https://doi.org/10.1080/09640568.2017.1305332>.
- Geiger, J.L., Steg, L., van der Werff, E., Ünal, A.B., 2019. A meta-analysis of factors related to recycling. *J. Environ. Psychol.* 64, 78–97.
- Giordano, C., Alboni, F., Cicatiello, C., Falasconi, L., 2019. Do discounted food products end up in the bin? An investigation into the link between deal-prone shopping behavior and quantities of household food waste. *Int. J. Consum. Stud.* 43 (2), 199–209 <https://doi.org/10.1111/ijcs.12499>.
- Given, L.M., 2016. 100 Questions (and Answers) About Qualitative Research. Sage, Thousand Oaks.
- Gregson, N., Crang, M., 2010. Materiality and waste: inorganic vitality in a networked world. *Environ. Plan. A* 42, 1026–1032 <https://doi.org/10.1068/a43176>.
- Ho, E., 2018. Exploring the social dimensions of multi-residential recycling. *Resour. Conserv. Recycl.* 132, 77–78. <https://doi.org/10.1016/j.resconrec.2018.01.027>.
- HUNTER, 2020. Food Study Special Report. HUNTER, New York City April 2020. <https://www.slideshare.net/HUNTERNY/hunter-food-study-special-report-america-gets-cooking-231713331> Accessed May 29 2020.
- Jribi, S., Ben Ismail, H., Doggui, D., Debbabi, H., 2020. COVID-19 virus outbreak lockdown: what impacts on household food wastage? *Environ. Dev. Sustain.* 22, 3939–3955. <https://doi.org/10.1007/s10668-020-00740-y>.
- Kalina, M., Tilley, E., 2020. “This is our next problem”: cleaning up from the covid-19 response. *Waste Manage. (Oxford)*. <https://doi.org/10.1016/j.wasman.2020.05.006>.
- Koivupuro, H., Hartikainen, H., Silvennoinen, K., Katajajuuri, J., Heikintalo, N., Reinikainen, A., Jalkanen, L., 2012. Influence of socio-demographical, behavioural and attitudinal factors on the amount of avoidable food waste generated in Finnish households. *Int. J. Consum. Stud.* 36, 183–191. <https://doi.org/10.1111/j.1470-6431.2011.01080.x>.
- Lakhan, C., 2016. Out of sight, out of mind: issues and obstacles to recycling in Ontario's multi residential buildings. *Resour. Conserv. Recycl.* 108, 1–9 <http://dx.doi.org/10.1016/j.resconrec.2016.01.005>.
- Martell, C., 2020. Regina Has Voted Out Plastic Bags but COVID-19 is Delaying their Demise. *CBC News* May 29 2020. <https://www.cbc.ca/news/canada/saskatchewan/regina-plastic-bag-ban-pandemic1.5589590>.
- Numerator, 2020. Numerator Canada 6/5 Update: the Impact of Coronavirus (COVID-19) on Canadian Consumer Behaviour. Numer. Intell. <https://www.numerator.com/resources/blog/impactcoronavirus-covid-19-canadian-consumer-behaviour-2>.
- Ordoñez, I., Harder, R., Nikitas, A., Rahe, U., 2015. Waste sorting in apartments: integrating the perspective of the user. *J. Clean. Prod.* 106, 669–679.
- Ouhssine, O., Ouigmane, A., Layati, E., Aba, B., Isaifan, R.J., Berkani, M., 2020. Impact of COVID-19 on the qualitative and quantitative aspect of household solid waste. *Glob. J. Environ. Sci. Manage.* 6 (4), 1–12. <https://doi.org/10.22034/gjesm.2020.04.0>.
- Quested, T.E., Luzecka, P., 2014. Household food and drink waste: a people focus. *WRAP* 128.
- Reuters, 2020. Locked Down Shoppers Turn to Vegetables, Shun Ready Meals. *New York Times* May 13, 2020 <https://www.nytimes.com/reuters/2020/05/13/world/>

- americas/13reuters-healthcoronavirus-food.html?searchResultPosition=5. Accessed May 26, 2020.
- Rousta, K., Bolton, K., Lundin, M., Dahlen, L., 2015. Quantitative assessment of distance to collection point and improved sorting information on source separation of household waste. *Waste Manage. (Oxford)* 40, 22–30.
- Silvennoinen, K., Katajajuuri, J.M., Hartikainen, H., Heikkilä, L., Reinikainen, A., 2014. Food waste volume and composition in Finnish households. *Br. Food J.* 116 (6), 1058–1068.
- Staats, H., Harland, P., Wilke, H.A., 2004. Effecting durable change: a team approach to improve environmental behavior in the household. *Environ. Behav.* 36 (3), 341–367.
- Staub, C., 2020 a. Some cities restart recycling as cuts continue elsewhere. *Resour. Recycl. Posted April 28, 2020*<https://resource-recycling.com/recycling/2020/04/28/some-cities-restart-recycling-as-cuts-continue-elsewhere/> Accessed May 27 2020,.
- Staub, C., 2020b. City data shows COVID-19 impacts on recycling. tonnages. *Resour. Recycl. Posted April 28 2020*,<https://resource-recycling.com/recycling/2020/04/28/city-data-shows-covid-19-impacts-on-recycling-tonnages/> Accessed May 27 2020,.
- City of Toronto (2020) Residential Diversion Rates 2019. <https://www.toronto.ca/servicespayments/recycling-organics-garbage/solid-waste-reports/>.
- Vann, K. (2020) Covid 19 puts BYO coffee cups on hold, but sanitized reusable systems could fill the void. *WasteDive March 25 2020*, <https://www.wastedive.com/news/byo-coffee-cup-reusables-coronavirus-covid-19-574817/>.
- Van der Werf, P., Cook, R., Hargreave, P., 2020. Summary of Finding Related to COVID-19 Impacts on Waste Flows: Week of April 27, 2020. Ontario Waste Management Association, Brampton, Ontario <https://www.owma.org/cpages/covid>. Accessed May 26, 2020.
- Wemyss, D., Cellina, F., Lobsiger-Kägi, E., De Luca, V., Castri, R., 2019. Does it last? Long-term impacts of an app-based behavior change intervention on household electricity savings in Switzerland. *Energy Res. Soc. Sci.* 47, 16–27. <https://doi.org/10.1016/j.erss.2018.08.018>.