

## Crying out over spilt milk: Quantifying formula milk waste in a large maternity hospital

M. Hannon<sup>1</sup>, E. O'Leary<sup>2</sup>, V. Daly<sup>1</sup>, C. Burke<sup>1</sup>

1. Department of Obstetrics and Gynaecology, Cork University Maternity Hospital, Co. Cork, Ireland.
2. Clean Technology Centre, Munster Technological University, Co. Cork, Ireland.

### Abstract

#### *Introduction*

Healthcare generates 5% of global carbon emissions, and its reduction will be a key part of meeting global carbon emission targets. Infant formula is an ultra-processed food with a large carbon footprint.

#### *Aim*

We aimed to measure infant formula waste at Cork University Maternity Hospital (CUMH). This was achieved by measuring the volume of milk and plastic bottles disposed of over a 5-day period.

#### *Results*

Our findings showed that an average of 4.7L of infant formula was discarded each day. Extrapolated figures estimate that 1,716L of formula are discarded per year in CUMH. This is equivalent to 23,568 full 70 ml formula milk bottles being discarded every year, resulting in an estimated cost of €12,019.68 per year. The carbon footprint of this wasted formula is just over 18 tonnes (18,150kg) CO<sub>2</sub> equivalent emissions annually, rising to almost 19 tonnes when the carbon footprint of the plastic bottles is included. Extrapolating out these figures suggests that the Irish Maternity system wastes more than €108,000 of formula annually requiring over 170 tonnes of CO<sub>2</sub> to produce.

#### *Discussion*

Strategies to reduce infant formula waste include greater encouragement of breastfeeding, decanting more appropriate volumes of formula milk from larger containers into sterile formula bottles, using reconstituted powdered milk and working with formula milk producers to reduce the volume of ready-to-use newborn infant formula bottles from 70mls to 40 or 50mls.

## Introduction

Healthcare accounts for around 5% of global carbon emissions. It is estimated that if the healthcare sector were a country, it would rank as the fifth largest polluter in the world<sup>1,2</sup>. In 2021, the government of Ireland released a climate action plan committing to a 51% reduction in public sector generated carbon emissions by 2030 and to the development of a carbon neutral economy by 2050<sup>3</sup>. Ireland's healthcare sector has an important role to play in achieving these ambitions, as outlined in the Health Service Executive (HSE) climate action strategy 2023 – 2050, which aims to reduce the environmental and social impact of the Irish healthcare system through sustainable procurement, reduced generation of waste and development of sustainable supply chains<sup>4</sup>.

Single use plastics (SUPs) are convenient and hygienic in a healthcare setting. Yet SUPs result in pollution, particularly of marine ecosystems, and the use of limited natural resources<sup>5</sup>. Single use plastic ready-to-use (RTU) infant formula bottles are provided free of charge to many women giving birth in Irish maternity hospitals. Formula feeding is chosen by mothers who are unable to or advised not to breastfeed, whose breastfed infants require top-ups of formula milk, or who have decided to exclusively formula-feed their infants. RTU infant formula is an ultra-processed food requiring complex production processes, transport, storage, and disposal resulting in a large environmental impact. It has been identified as a significant waste item in Irish maternity hospitals, generating both food and plastic waste<sup>6,7</sup>.

In this study we aimed to quantify daily and estimate annual formula milk waste generated in Cork University Maternity Hospital (CUMH), a large Irish maternity hospital. This allowed us to determine the volume and cost of wasted infant formula. Given the environmental impact of this waste, we hoped to identify ways of reducing RTU infant formula waste in order to reduce waste and the carbon footprint associated with our maternity hospital's use of this product, as well as reducing cost. This work was funded by the Health Service Executive's Climate Action and Climate Infrastructure Office.

## Methods

Over a 5-day period in August 2022, the total number of both 70 ml and 90 ml RTU infant formula bottles used in all three postnatal wards and the neonatal unit of CUMH were quantified each day. The volume of formula milk remaining in each bottle was recorded before disposal. The average number of bottles used daily was calculated, as well as the average volume of milk discarded per bottle, and the average volume of formula milk discarded per day. Using available information on the procurement costs of RTU infant formula bottles an estimation of the cost of the waste generated in the hospital on a yearly

basis was estimated. Using available information on carbon emissions associated with the production of formula milk, the annual carbon footprint associated with wasted formula milk and associated plastic bottles in our unit was estimated.

An informal qualitative survey of the postnatal and neonatal wards nurses in CUMH was concurrently performed to gain views on formula milk waste generated in CUMH. Midwifery and neonatal nursing staff in all areas were invited to give feedback as part of informal interview sessions where all staff were given the opportunity to voice their experiences and opinions on the use of RTU infant formula in CUMH. Comments were recorded verbatim and then analysed for any overarching themes.

## Results

A total of 777 single-use formula milk bottles were used in CUMH over a five-day period, giving an average usage of 155 bottles per day (Table 1). The 70 ml formula bottles were used in all three postnatal wards, while the neonatal unit used both 70 ml and 90 ml sized bottles. The 90ml formula bottles contained formula specific to preterm infants. On average, 27mls of milk remained in formula bottles after each feed. The average volume of formula milk consumed per feed was 47 mls (Table 2). Forty per cent of formula bottles contained almost forty per cent (39.4%) of their original milk volume at the time of disposal, with 13% of bottles having 70% or more of their original volume of milk disposed (Table 2).

It was calculated that 4.52 L of formula milk was disposed of daily in CUMH. Extrapolation of this figure suggests that a total of 1,650 L of formula milk waste is generated in CUMH on a yearly basis. This is the equivalent of 23,568 individual 70 ml formula bottles of waste generated by CUMH per year (Table 1). The cost of this volume of wasted milk was estimated to be €12,019.68 every year based on the procurement cost of €0.51 per 70ml bottle of RTU formula.

The annual emissions associated with wasted formula milk in CUMH was estimated at just over 18 tonnes (18,150 kg CO<sub>2</sub> equivalent emissions). This is based on UK data stating that for every 1 kg of formula milk consumed, 11 kg CO<sub>2</sub> equivalent emissions is generated<sup>8</sup>. Unfortunately, we were unable to find published data for carbon emissions associated with formula milk manufactured in Ireland.

Each 70 ml formula bottle weighs 10g when empty, meaning that 236kg of plastic waste is associated with our annual formula milk waste. This has a carbon equivalent of 732 kg CO<sub>2</sub> emissions a year, based on a conversion factor of 3.1kg CO<sub>2</sub> emissions per 1kg “formed polypropylene” which is produced from oil<sup>9</sup>. When added to the 18,150 kg CO<sub>2</sub> generated by

the production of the disposed milk itself, this brings estimated total carbon emissions from wasted formula to just under 19 tonnes CO<sub>2</sub> annually (18,882kg).

The analyses of verbatim feedback on the use of RTU infant formula bottles in CUMH Identified three themes: the amount babies drank, the waste associated with 'Top Up' feeds, and premature feeds (Table 3). The first theme related to the volume of formula consumed per feed. Staff reported that neonates typically consume significantly less than 70mls or 90mls per feed in the first few days of life (Table 3). The second theme related to formula top-ups, staff commenting that neonates consume a very small volume, typically 10mls of formula milk per top-up feed. This resulted in the disposal of a large amount of unconsumed formula. The third theme related to the neonatal unit, where very small but frequent volumes of formula from 90ml bottles are used to feed premature infants, generating a large volume of waste given that the bottles must be disposed of immediately after use.

## Discussion

The disposal of partially-consumed RTU infant formula bottles containing relatively large volumes of formula feed generates avoidable waste and represents both environmental and cost burdens for CUMH. This environmental burden is expected to be found in all maternity and neonatal units nationally. CUMH disposes of the equivalent of 23,568 70 ml RTU formula bottles annually costing €12,019.68 and with an estimated carbon footprint of almost 19 tonnes CO<sub>2</sub> equivalent. This in itself is a conservative estimate, as the carbon emissions relating to packaging and transport of formula feed are not included. Given the environmental impact, as well as the cost associated with formula milk waste, strategies to reduce this waste are imperative.

The most environmentally-friendly, as well as (in the majority of cases) infant-friendly, feeding strategy for neonates is encouragement of breast feeding. Ireland has one of the lowest rates of breastfeeding in Europe, with just 6% of infants in Ireland being exclusively breastfed until 6 months of age<sup>10</sup>. CUMH's statistics indicate that in 2023 approximately 60% of mothers initiated breastfeeding, but only 30% were still breastfeeding by the time they left hospital. These numbers have been consistent over the last six years. There is no doubt that socio-cultural factors are involved in the uptake and continuation of breastfeeding with breastfeeding rates amongst women born in Eastern Europe delivering in Ireland vastly exceeding those of women born in Ireland<sup>10</sup>. Increasing our rate of breastfeeding mothers could result in significant waste and cost savings but, more importantly, contribute to improved infant health. Epidemiological research shows that children who are breastfed for long periods have lower infectious morbidity and mortality, and seem to be protected against obesity and diabetes in later life<sup>11</sup>. For mothers, there is good evidence that breastfeeding can prevent breast cancer and lower women's risk of diabetes and ovarian cancer<sup>11</sup>. The

Health Service Executive Breastfeeding Action Plan 2016-2021 for Ireland sets out a number of strategies to increase breast feeding rates in Ireland which includes increased training for healthcare staff, increased support for breastfeeding mothers, and implementation of the WHO code of marketing for breast milk substitutes as some of their key policies<sup>12</sup>. These were reiterated in the more recent “National Standards for Infant Feeding in Maternity Services” published in 2022. This describes the optimum care with infant feeding as part of the HAS Baby Friendly Initiative which seeks to implement the 10 core components for breastfeeding as implemented in 101 countries worldwide<sup>13</sup>.

Concerns have recently been raised regarding the association between overfeeding in the early neonatal period, and childhood obesity. Though the capacity of a newborn baby’s stomach in the first few days of life is difficult to measure, it is reported to range from between 5 and 20mls on day 1 of life to 22-30mls by day 3 of life<sup>14,15</sup>. A US study published in 2020 revealed that consumption of 30mls or more formula milk in 5 of a neonate’s first 7 feeds is associated with a 5 times higher rate of childhood obesity<sup>15</sup>. Thus, the provision of 70ml formula bottles for each feed in the early neonatal period is problematic as parents may not have an awareness of the volume of milk a newborn baby’s stomach can hold in the first few days of life, and thus risk overfeeding their babies with formula feed. Our study results certainly point toward a trend in over-feeding newborns, with an average feed volume of 47mls during the study period. This is a cause for concern, and correlation with feeding charts completed by mothers in the postnatal period in our maternity unit is now being considered. Also concerning is the volume per bottle of formula feed produced specifically for preterm neonates. Despite the fact that the stomach volume of a preterm neonate is even smaller than that of a term neonate, the only volume option available for this formula bottle is 90mls. There is little justification for this, as this product is not generally used outside the neonatal unit.

An informal qualitative survey of staff performed as part of this study revealed possible solutions to this issue, such as manufacture of smaller volume of these single-use units which could reduce the amount of waste that is disposed of after each feed.

Phasing out free supply of RTU infant formula bottles in Ireland’s maternity units is an obvious way to reduce the hospital’s carbon footprint as well as reduce cost. Other healthcare systems do not routinely provide formula milk to parents outside of the neonatal unit, mothers who wish to bottle-feed are instead encouraged to supply their own. Though this may address the financial cost of wasted formula milk for our maternity hospitals and units, it does not impact on the volume of wasted milk per RTU bottle if used.

Whether by patient choice or for practical reasons there will always be a need for formula milk feeding, thus work towards lowering the carbon footprint of infant formula is also

necessary. A switch from RTU to reconstituted powdered milk could be achieved through the development of a milk kitchen staffed with appropriately-trained staff. Setting up a milk kitchen would also allow the hospital to switch to re-usable containers. We acknowledge that this would involve costs and logistical challenges for the hospital through the need for additional staff and resources and would have its own associated carbon footprint. Funding of this could be partly offset by savings made from the purchase of less formula milk product. A less labour-intensive alternative would involve sterile decanting of a more appropriate volume (30-40mls) of formula feed from larger containers provided by formula companies e.g. 1L formula milk containers into bottles such as those currently used for expressing breast milk.

Other strategies to reduce formula milk and plastic waste could include working with manufacturers to encourage production of smaller-volume formula bottles. There is a precedent for this, with formula companies having previously reduced the volume of formula bottles from 100mls to 70 mls around a decade ago.

In conclusion, the use of RTU infant formula represents significant waste and financial costs for our maternity units. We estimate that CUMH disposes of an estimated €12,019.68 worth of unconsumed formula annually. Around one in every ten babies born in Ireland (6,382 of 57,540 births; 11%) were delivered in CUMH in 2022<sup>16,17</sup>. Formula milk waste nationally could represent a financial cost of approximately €108,370 a year to our maternity healthcare system. Extrapolating out the calculated estimated carbon emissions of 18,882kg of CO<sub>2</sub> produced to manufacture the estimated 23,568 individual 70 ml formula bottles of waste generated by CUMH per year gives us just over 170 tonnes (170,240kg) of CO<sub>2</sub> generated annually in wasted RTU formula by our maternity network. Reducing wastage of RTU formula milk and bottles will reduce our hospitals' carbon footprint and provide cost savings. Greater uptake of breastfeeding with its associated benefits of reduced rates of childhood obesity and diabetes in later life represent potential longer term cost savings for our healthcare system.

**Declaration of Conflict of Interest:**

None declared.

**Corresponding author:**

Maura Hannon,  
Department of Obstetrics and Gynaecology,  
Cork University Maternity Hospital,  
Co. Cork,  
Ireland.

E-Mail: [maurahannon@gmail.com](mailto:maurahannon@gmail.com)

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## Tables

LOCATION	No of bottles used					TOTAL BOTTLES
	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>	
WARD A	-	20	22	9	55	106
WARD B	-	25	39	48	56	168
WARD C	-	41	18	39	48	146
Neonatal Unit	90	59	59	67	82	357
<b>TOTAL</b>	90	145	138	163	241	777
<b>Average/Day</b>						155.4

  

LOCATION	Volume of milk discarded (mls)					TOTAL VOLUME FORMULA MILK DISCARDED (MLS)
	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>	
WARD A	615	893	753	294	1,866	4,421
WARD B	534	748	973	1,223	1,532	5,011
WARD C	0	987	630	832	1,366	3,816
Neonatal Unit	2,441	1,669	1,558	1,470	2,213	9,352
<b>Total volume formula milk discarded (mls)</b>	3,590	4,298	3,915	3,820	6,978	22,600



	Per Day (mls)	Per Day (L)	ESTIMATED PER YEAR (L)
<b>Average volume formula milk discarded (mls)</b>	4,520	4.52	<b>1,649.79L</b>
<b>Equivalent 70ml RTU formula bottles</b>	65	-	23,568

**Table 1:** Number of infant formula bottles and volume of infant formula discarded in CUMH over a five-day period with estimated annual figures

<b>AVERAGE VOL OF MILK CONSUMED PER BOTTLE</b>	43mls	
<b>AVERAGE PERCENTAGE OF MILK DISCARDED PER BOTTLE</b>	40%	
	<b>Number</b>	<b>%</b>
<b>TOTAL NUMBER OF FORMULA BOTTLES ASSESSED</b>	777	-
Bottles containing >50% of their original volume after feeding	306	39.4%
Bottles containing > 70% of their original volume after feeding	98	12.6%

**Table 2:** Average volume of milk per bottle and % of milk bottles containing 50% and 70% of their volume discarded during the five-day study period.

<i>Theme 1: Amount Babies Drink</i>	<p>“The vast majority of babies are first or second day only and need 30 mls.”</p> <p>“The majority of babies at day 1 and day 2 won't drink more than 40 mls. A second option of a smaller bottle would be perfect for this.</p> <p>“Some babies might still be in on day 3 e.g. after a section and might drink more.”</p> <p>“I give 6 bottles per day per baby. Typically they take about 30 mls. I think they should just reduce the volume.”</p>
<i>Theme 2: Top Ups</i>	<p>“For breast feeding, you are only topping up, and use only 10 mls or so.”</p> <p>“The majority of what I throw out is top ups. A lot of mums breast feed.”</p>

*Theme 3:* "Nutriprem and Prem 1 are the ones wasted the most, only a few mls used  
*Premature* per baby."  
*Feeds*

"We used to keep the opened bottles in the fridge but not allowed to any longer."

"There is a baby currently in neonatal that is only on 4 ml of Nutriprem. I have to dump the rest of the 90 ml bottle each time."

**Table 3:** Qualitative data – feedback from the staff of CUMH organised around themes that emerged from informal staff survey.