Blood, Sweat and Tears

The struggle for human rights in the age of microplastics

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Abstract

This paper seeks to establish and assess the link between microplastics and human rights. An empirical understanding of the topic is constructed through the collection and presentation of emerging research on the impact of microplastic pollution on the environment, health, well-being, and reproduction. A sociological and environmental justice perspective and understanding of the topic is established through a presentation of previous cases of pollution and issues of global health. These theoretical and empirical perspectives are then explored through the lens of a human rights framework to establish an understanding of the potential threat posed to human rights by the issue of microplastic pollution.

Key words: *Microplastics, Pollution, Health, Environmental Justice, Human Rights*

Word count: 13,123

Abbreviations

- BPA - *Bisphenol A (Chemical compound used to produce certain plastics)*
- CEDAW - *Convention on the Elimination of All Forms of Discrimination against Women*
- DEHP - *Di-2-ethylhexyl phthalate (Chemical used to increase the flexibility of plastic)*
- ICESCR - *International Covenant on Economic, Social and Cultural Rights*
- MP - *Microplastic (plastic smaller than 0.5 millimetres)*
- NP - *Nanoplastic (plastic smaller than 100 nanometres)*
- PBDE - *Polybrominated diphenyl ethers (Chemical used to reduce plastics flammability)*
- UDHR - *Universal Declaration of Human Rights*

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1.Introduction

The invention and use of plastics is a relatively recent development in the scale of human history, but the extent to which we have become reliant upon them and the impact they have had is so large that some scholars have dubbed our modern era as the Plasticene, alluding to just how extensive and long-lasting an impact this discovery will have on the course of human history (Rangel-Buitrago et al 2022 p.2). Knowledge of the problems plastics present to the planet is almost as widespread as their use, however the true extent to which microplastic pollution presents a macro problem is only being revealed now. Microplastics can be hard to define as they differ in shape, size and origin, however we can recognise it as an umbrella term encompassing plastics that are smaller than five millimetres but can be as small as mere micrometres. (Andrady 2017, p.14).

While the majority of literature written about microplastic pollution has been written in the last five years, it is not a completely novel issue, with concerns about detection of plastic particles in our oceans and marine life being raised as early as 1971 (Carpenter et al, 1972. p.749). The true scope of their impact is only starting to be revealed now, with recent research observing just how far they have reached and investigating their impact on environmental and global health (Boyd, 2023, para 8). The recent uptake in research on the impact of microplastics isn't surprising given the increased availability of material to study. This is due to the fact that plastic production has steadily increased since the 70s when they were already detectable in our oceans, to the point in 2021 when global plastic production was recorded as "more than 400 million metric tons per year"(Millican & Agarwal, 2021 p4456) and is expected to quadruple by 2050 (Orellana, 2022, para 5). Our reliance on plastics and treating them as "a basic human need."(Millican & Agarwal, 2021 p.4456) has left us in a position where microplastic exposure is almost inescapable (Orellana, 2022, para 3). In this paper I aim to understand how that exposure manifests and the extent to which it impacts our well-being and if by extension it can be said to threaten our rights. To achieve this understanding, I therefore propose to answer the following research questions;

Do microplastics have an impact on health and well-being?

Do microplastics have an impact on fertility and reproduction?

Do microplastics pose a potential threat to human rights?

The current limitations that exist, due to the lack of an established connection between the fields of human rights and microplastics, require a multidisciplinary research analysis and a presentation of available findings to confirm a threat posed to human rights by microplastics. Through collecting, observing and analysing the currently available research and findings on microplastics, I achieved an understanding of the overarching issues presented by microplastic pollution. I further established a novel connection between microplastic pollution and human rights, exploring the potential dynamics that exist between the observed issues and an established human rights framework.

2.Theoretical and Methodological Considerations

2.1. *Analysis of microplastic literature*

To understand whether microplastic pollution presents a threat to human rights it is necessary to first have an established understanding of the impact microplastics have on humans.
The lack of connection between the research fields of microplastics and human rights became evident during my research process. I began by using Google Scholar for research, in the initial process I aimed to keep the parameters open to gain an understanding of the general layout of the research field, using the key search terms, “Microplastics & Human Rights”, “Microplastic Pollution” and “Microplastics & Health” , with my only limitation being a requirement for papers to be available in English.

During the research process into the field of microplastics, I did narrow my research parameters chronologically, favouring more up to date research (since 2020). I further focused my parameters to prioritise human based research models. Due to a lack of literature on microplastics within the field of sociology, I extended my research parameters to include those papers which referenced pollution or global health. However, when attempting to find relevant material which addressed the impact of microplastic pollution on human rights, there was an evident research gap even with the widest parameters.

I therefore extended my literature search beyond Google Scholar to explore whether a connection had been made between Human Rights and microplastics within discipline specific journals. I checked established human rights journals such as The International Journal of Human Rights for the key term microplastics with no results, similarly I checked relevant scientific journals such as the International Journal of Environment and Pollution Research and the International Journal of Plastics Technology for the combined key terms of human rights and microplastics, returning nil results.

This highlighted to me the gap that existed in terms of connections between the two fields and the requirements of a strong empirical and sociological understanding to be presented to support this novel connection between microplastics and human rights. My research into the literature on microplastics revealed a common and widely accepted theme, that microplastics pose a risk to human health, well-being and reproduction, which I based my thesis upon.

I did also attempt to research the literature to explore the alternative and null hypotheses; that microplastics are inert and only present minimal effects by their presence in the human body before passing through. I also sought evidence in the literature that microplastics have no impact on human health and well-being, however I found no data supporting either of these claims.

The current lack of collaborative research between the social science and human rights fields, on microplastic pollution, means that there is a requirement for this thesis to draw together a combination of different styles of research paper, resulting in a multidisciplinary research analysis. The structure of this thesis includes the presentation of three themed chapters - Microplastics, Environmental Justice and Human Rights. These chapters encapsulate a critical analysis of each theme as identified in the research, explaining how they contribute to answering the research questions. Due to the novel and emerging nature of the field of microplastic research, it is not surprising that there is a research gap between microplastics and human rights. However, this means I cannot simply build on the theoretical understanding of empirical data from human rights scholars before me, I must first observe the empirical findings from the field of microplastic research, to establish the extent to which they pose a threat to humans. Hence, to answer my research questions and provide a strong empirical foundation for my thesis, my methodology must begin with a multidisciplinary research analysis of the data from the literature to answer the following questions.

What are microplastics?
How are they created?
Where are they found?
Do they impact our health and well-being?
Do they impact our ability to reproduce?

While there is plenty of literature on the broader impact of plastic pollution, exploring the data to answer these questions specifically in relation to threat from microplastics is necessary, as it provides the understanding that microplastics are a unique pollutant and hence behave differently to other pollutants. They are having effects unlike other, more well-known, pollutants and are not necessarily limited by legislation designed to protect against broader pollution, making them a unique threat to human rights.

2.2. Contextualisation

While the establishment of an understanding of microplastics from the empirical data and scientific papers is necessary, it is not sufficiently informative as to the social factors that influence and impact the existence and persistence of microplastic pollution.

This is where the use of previous cases of pollution and research, grounded in a sociological framework and based in the wider field of the environment, pollution, global health, and environmental justice can be used to compare, inform and frame an understanding of microplastics and human rights. These comparative cases are useful in providing an understanding of the wider context in which the issue of microplastic pollution arises. They are informative as to how similar issues have been tackled before and hence can potentially provide answers as to how microplastics can be understood and applied in a human rights setting. Additionally, these comparative cases can deepen our understanding by highlighting the differences in outcomes between microplastic pollution and seemingly similar cases of pollution. The contextualisation provided by case comparison, builds an understanding of the specific niche inhabited by the interaction between microplastics and human rights. When this niche is viewed within the wider research field it has the potential to narrow the identified research gap.

2.3. Application of human rights framework

Building an extensive understanding of microplastics, the threat they pose and the relationship they have with social factors, legislation and other pollutants, is key to understanding whether they pose a specific threat to human rights. Once the empirical, biological, and sociological understanding of microplastic pollution is established, it is key to ground it within a human rights framework. This is done by the application of relevant human rights articles to the established understanding of the issues surrounding microplastics, and analysing whether they sufficiently meet the conditions to constitute a potential violation of said articles and rights.

It is key here to explore the level to which these articles are ratified and upheld internationally. It is not necessary to provide an answer as to the efficacy of human rights treaties and resolutions in preventing and responding to issues of pollution, as this is not the aim of this thesis. However, it is important to understand the level to which each document is internationally recognised and legally binding. This informs us as to the level to which the threat of microplastic pollution potentially presents a direct violation and therefore a justification for legal action, or, just presents a threat to the underlying principles and values of these international agreements.

3.Microplastics

3.1. Understanding microplastics

To understand the impact that microplastics have on us, our rights, and the planet we must first gain an understanding of what is meant by the term microplastic. It is a term that encompasses "a surprisingly broad range of particles sizes varying from ~5 mm (e.g. virgin resin pellets) to those a few microns in diameter."(Andrady 2017, p.14). This highlights one of the reasons microplastic pollution poses a unique threat; its unique and complex nature as a pollutant. Unlike other pollutants which present in a consistent chemical and physical form, microplastics are multifaceted and appear in a range of chemical compositions, sizes, shapes and colours. A threat that is so multifaceted is a threat that is hard to observe, understand and control.

Another feature of microplastic pollution that makes it a unique threat is its ubiquity. The range of sizes partially accounts for their ubiquity, with some microplastics being invisible to the human eye, they are small enough to be transported with extreme ease in both air and in water, they have even been found to be present in soil. (Haque & Fan 2023

pp.5,11,12). Another cause for the ubiquity of microplastics is the sheer range of sources from which they originate. Unlike other cases of pollution such as oil spills or dumping of toxic waste, microplastic pollution does not stem from one source alone. The microplastic pollution in our environment to which we are all exposed, emanates from the plastics that we use every day.

Plastic as a material is extremely useful due to its innate properties. Plastics are considered to be chemically inert, stable, cheap, and durable; however, it is these same advantageous properties that also present problems. These properties are innate and do not disappear due to biodegradation, they merely persist in smaller, more toxic, and harder to control particles – which are referred to as microplastics (Millican & Agarwal, 2021 p4456). This resistance to decomposition means that the microplastics are not broken down and reused by our ecosystems, but rather they persist, remaining a pollutant, unable to naturally integrate and continuing to prolong our exposure.

Our creation and consumption of microplastics is extensive. They are key in the manufacturing process of the plastic products that we have made ourselves dependent upon. Known in the industry as mermaid tears, these plastic pellets are used to form larger plastic items of whatever size and shape required. They are also key in many beauty products with plastic microbeads being commonly added for exfoliating purposes. It is not only our direct creation of microplastics that causes microplastic pollution, but also the extensive use of plastic products, which we eat off, drink from and use for packaging and clothes, which shed microplastic fibres with every use, wear and wash (Millican & Agarwal, 2021 p.4455).

The washing of microplastics down our drains ensures we are providing our waterways with a regular supply of microplastics, which have been detected since 1971 (Carpenter et al, 1972. p.749). These microplastics are then free to spread further with the flow of tides and streams as well as into any organism that inhabits these bodies of water or depends upon them for sustenance. Microplastics have a negative cyclical relationship with climate change, contributing to the problem through a variety of mechanisms. The production of microplastics itself increases greenhouse gas emissions (Parvez et al 2024 p.20), while the presence of microplastics in the marine environment limits the ability of our “ecosystems to remove greenhouse gases from the atmosphere” (Boyd 2023, para 7). Furthermore the spread of microplastics is exacerbated by the effects of weathering on plastics which is heightened with increasing occurrences of extreme weather due to climate change (Haque & Fan 2023 p.3).

Concerningly, due to the nature of microplastics being micro they can also be airborne and even "reach the upper layers of the atmosphere via wind due to their low density" (Padha et al 2022 p.2). This highlights the issues in containing and controlling microplastics as pollutants; while this issue may not initially be as visually disturbing as more acute localised cases of pollution, it is extremely widespread and no less threatening. The unique case of microplastic pollution's ubiquity is confirmed in evidence of the existence of microplastics in the "deepest parts of our oceans and even Mount Everest" (Padha et al 2022 p.7). This evidence is highly concerning as it suggests that there is very little freedom for humans to enjoy a clean and healthy environment, the literature cited above shows that even in the regions where rates of plastic use (especially single use plastics) is lower, prevention of exposure to microplastic pollution is not ensured.

Cumulatively the function of the literature explored in this chapter is to provide an understanding of what microplastics are and who could potentially be interacting with them. Having established an understanding of what constitutes a microplastic and where we may be exposed to them, I then moved my research to their presence and effect in the human body.

3.2. Impact of microplastics on human health

As recently as 2020, it was being argued that the assessment of human health risks posed by nano and microplastics is not currently feasible (Brachner 2020). However, our inability to assess the risk should not be misconstrued as claiming that a risk to human health does not exist, but that our capacity to understand and measure this risk was at that time hampered by a lack of data and would require further exploration. Advances in this research field in the last four years (which will be presented in this paper) have coalesced in a rising concern about the impact of microplastics on human health. Future research may indeed assess the risk to human health as being much greater or much less than currently understood, however I must limit myself to exploring what is currently known in this field.

With an established understanding of the ubiquity of microplastics in our environment, it is necessary to distinguish the level of impact they have on humans, to understand whether they impact us only indirectly via impacting the environment we live in, or have further, direct impacts on human health and well-being.

The research from Yee at al (2021) below, outlines for us the mechanism by which microplastic pollution can find its way from the environment into the human body, indicating

that the pollutive capacity of microplastics is both subdermal and insidious, as absorption and ingestion can occur without our knowledge or consent.

> *While, the skin membrane was too fine for microplastics or nanoplastics to pass through, it is possible for them to enter through wounds, sweat glands or hair follicles. Although all three routes contribute to the total amount of microplastics and nanoplastics present in the human body, it is the particles in seafood and the environment that constitute the greatest risk of absolute exposure.*
>
> Yee et al 2021, pp4-5

The previously discussed prevalence of microplastics in our environment, air and waterways means that they are available for us, not only to consume directly from the plastic products we use as individuals, but also from the air we breathe, the water we drink and the food we eat. This is a problem as it means we are directly consuming these pollutants, and we are consuming them more quickly than we can expel them. "The rate of elimination via e.g. the biliary tract, kidney or transfer to and deposition in organs is slower than the rate of absorption into the blood." (Leslie et al 2022, p.7).

The fact that we have microplastics in our blood is extremely concerning as this indicates that not only are they interacting with the circulatory system but are able to be transported to all other parts of the body, carried by the blood. While presence in blood alone cannot be assumed to indicate a definitive marker of harm to human well-being, it is important to note the implications of this finding. The presence of microplastics in our blood has not only direct implications, (such as the fact that if they are in our blood they are able to be transported to every part of our body) but also broader implications in relation to our immune systems. It is widely understood that a function of the immune system is to identify and respond to the presence of foreign bodies and therefore this raises the question as to whether microplastics might be triggering an immune response or impeding the ability of the blood to perform its necessary functions such as carrying oxygen, nutrition or immune cells.

Recent research by Yang et al confirms that microplastics “can be taken up by cells, thus disrupting the intracellular signalling pathways, altering the immune homeostasis and finally causing damage to tissues and organs.” Yang et al (2022).There is also concern given plastics aforementioned durability, that unlike some pollutants, toxins, or pathogens (which

our bodies can combat and break down) microplastics persist and prolong our exposure to any potential damage inflicted by them.

Given microplastics' ubiquity in the environment, air and water and presence in our blood we can also begin to see some of the issues this poses to the idea of free choice, especially regarding our health. As microplastics are found throughout the biosphere to the extent that they are present in the bodies of organisms we consume, the agency of an individual who chooses the products and produce that are not wrapped in plastic (to avoid exposure to plastic) is undermined. Pollutants that are so widespread that they reach the furthest extremes of our environment and fill our bloodstream are a cause for great concern. It could be argued that it would be prudent that microplastic pollution should be met with a response that reflects the level and gravity of the impact that they have on both the environment and upon global health.

When analysing the impact of microplastics on human health, observing their presence in human blood is only the first step. Whilst microplastic presence in blood is concerning, it is not enough to only understand that they are present in our bodies, we must also understand what effects this presence has on our health and well-being.

Since we can eat and drink from plastic containers, with no apparent negative effects it might be assumed that plastic must be relatively harmless even if consumed, and hence, despite being a relatively recent phenomenon for humans, it is not one that causes widespread concern. However, while research is only emerging in this nascent field, it firmly contradicts this assumption and already we can see that "there is enough evidence to suggest that microplastics may have negative impacts on human health" (Ghosh et al 2023, pp.7-8).

The early research of Ghosh et al (2023) further suggests that the presence of microplastics in the blood may increase the likelihood of heart attacks or strokes and premature death if lodged in key blood vessels. More than this, it can also impact everything that relies on the blood, (to wit, the whole body) affecting transportation of nutrients, oxygen and the hormones that regulate the functions in our body as well as removal of waste. The effects of microplastics on the transport and regulation of hormones such as melatonin, has been found to impact the circadian rhythm, which controls our sleep and has wider implications for our health and well-being. They also can cause damage to our organs, causing damage to the intestinal wall and affecting the gut microbiome which impacts our overall physical and mental health. Microplastics have also been found to cause respiratory and skin inflammation and damage. These highlighted issues already present enough reasons for concern, however it is further suggested that there are many more health issues that

“microplastics are likely to have an impact on, such as obesity and immune diseases.” (Ghosh et al 2023, pp.7-8)

This nascent field of research is gradually revealing to us the potentially catastrophic domino effect that something as small as microplastics can have on our health. Understanding the impact of microplastics on human health and well-being requires an understanding of the body as a whole and the interconnectivity of internal systems. As highlighted in previous sections, microplastics possess the ability to impact our overall health including systems that are key in sustaining health and fighting disease, such as cardio-vascular, circulatory, gastrointestinal, respiratory and immune systems. With this understanding we can see that once microplastics are in our bodies the effects that they may have are extensive and go far beyond the simple issue of irritation when consumed or inhaled. "There are several negative health concerns resulting from the absorption of plastic particles, particularly micro- and nanoplastics, such as particle toxicity, chemical toxicity, and the introduction of pathogens and parasite vectors" (Yee et al 2021. pp.6-8). In addition to clarifying the multiple modes of access into the body, (by breathing, consumption, sweat glands and hair follicles) Yee et al’s research here confirms that beyond the harm caused by the microplastics themselves (due to their chemical and physical composition), there are further risks that they become vectors for pathogens and parasites into the body. Yee et al. report that microplastic particles were found to provide a strong and stable vessel that can damage human defences; pathogens and parasites can then cling on to this vessel of microplastic and are provided with an already established point of damage and entry to the human body.

When the various research articles in this field are considered in combination, we can start to see how quickly a substance that can be invisible to the human eye and stems from something that is considered harmless enough to eat and drink off, (even for infants, new-borns and the immunocompromised), can have drastic impacts on our health. This harm can be caused through an introduction of pathogens and parasites at the same time as lowering of our ability to defend against them, through its impact on the immune system and overall health.

Whilst this is an emerging field of research and hence there are not extensive levels of data upon which to draw, it is important to observe that these small levels of available research for analysis are reflective of a shorter period of study rather than a field lacking in statistical significance. Indeed, as the literature is developing with each consequent study the developing picture becomes increasingly concerning, as within a year of the findings of the Yee et al research cited above, it was confirmed again in another study that "both chemical

and physical effects influenced the observed toxicity. Chemical effects were hypothesised to be related to the release of chemical reagents from the MPs, while the physical effects came from the direct damage of cellular membranes" (Danopoulos et al 2022, p.14). This paper adds to the growing collection of findings on the impact of microplastics on human health, by confirming the ability of microplastics to act as both chemical threats (by what they release into the body) but also as physical threats due to their ability to directly damage cellular membranes.

When gathering data to understand a specific phenomenon, the repetition and confirmation of the same ideas across research papers (even though it may be limited by being small-scale or in vitro research) is useful as it strengthens the reliability of a thesis based on their conclusions. While it is important to exercise caution when extrapolating larger trends from small scale studies, it should be noted that, even in the relatively short time period during which these studies have been undertaken, the same concerning issues have repeatedly arisen and been further recorded and researched. When explored in combination, each consequent study has confirmed, validated and expanded further upon the theme that microplastic pollution is a pressing issue in terms of global health.

It is especially important to note the damage that microplastics have on cellular membranes. Cells are the building blocks of all living organisms, and the observation of damage to cellular membranes strengthens our understanding of how microplastics can affect overall health and well-being. The research presented in this section confirms that not only are microplastics present in our bodies, but they are present throughout our bodies and are having a negative impact on our health and well-being all the way down to a cellular level. This is a cause of concern for global health, because when understood in the context of previous research (which informed us as to the extent of microplastic pollution in our planet), we see that this is an issue of pollution affecting health on a global and humanity-wide scale. Therefore microplastic pollution is a pressing issue of global health that requires not only immediate global action, but will require international cooperation if it is to be addressed successfully.

3.3 Impact of microplastics on male fertility and reproduction

Microplastic pollution presents a unique problem, in that it does not just affect one area or group of people in one way, it has far-reaching potentially intergenerational impacts. The issue that microplastic pollution poses is not just one of immediate disease and life

quality/expectancy but also that of fertility. As previously discussed, there are microplastics small enough to enter the bloodstream and travel throughout the body. This ability to travel throughout the body means that microplastics can reach and bio-accumulate in every organ, including the brain. This is highly concerning given the context of previous research that established the cellular as well as wider level damage that can be caused by microplastics.

The sex organs and gonads are no exception, as shown in microplastics' ability to "bio-accumulate in mammalian tissue, including the testis, with outcomes on semen quality in rodents" (D'Angelo & Meccariello 2021, p.7). This paper illustrates how microplastics were found to bioaccumulate in mammalian tissue including the testis, however it is important to note that the mammalian tissue that was tested here was that of rodents. This is a limitation when attempting to make hard conclusions on the impact of microplastics on the health and reproductive ability of human males. However, it remains relevant as it is informative and acts as an early warning system not only for human reproduction but also the reproductive ability of other organisms that inhabit this planet and upon which we depend for food and other materials. Mammals tend to share a lot of the same biological characteristics and hence tend to react similarly to toxins, which is the reason rodents are used in pre-clinical trials, hence not only is it informative in regards to the findings on potential impact on humans but also the fact that it is being tested in rodents points to existing concerns and sets the precedent for testing on human based models, this is noteworthy in and of itself.

The bio-accumulation of microplastics in the testis is of great concern as with the knowledge of the ability of microplastics to cause cellular damage, we can hypothesise and understand the impacts this will have on these organs ability to carry out their functions as well as the quality of what they produce. This potential for destructive impact at a cellular level is particularly impactful upon the production of gametes or reproductive cells such as sperm, as they are single celled. Further research confirmed that these microplastics bio-accumulate in the testis and that they have outcomes on the semen quality too (Zhang 2022, p.3)

In an emerging research field such as this it is also important to continue to observe research as it is published and reflect not only upon the findings of each individual piece of research, but also upon the wider patterns and trends that begin to appear within the field. Within the field of research on the impact of microplastics on health, we can see a developing trend, that despite the tighter restrictions in human based research models, the limited human-based studies reflect the same patterns of toxicity and damage that animal based research models do. This is confirmed by Zhao et al's emerging research "that microplastics

play a role in male fertility in humans with microplastics being found present in both semen and testis" (2023, p.4) showing that the previously highlighted "concerns for human fertility based on rodent models have been confirmed to be well founded" (Zhao et al 2023, p.4)

It is important to note from these papers the impact of microplastic pollution, as not only is it impacting our health and well-being but potentially has the impact to limit our ability to reproduce and hence poses a threat to not only this generation but also many generations to come. From the research cited, a pattern emerges which implies that microplastic pollution may undermine the idea of free choice not only in personal health and well-being but potentially also in family planning. It cannot be claimed that microplastic pollution is the only reason for the trend of lowering sperm counts over the past 50 years that are speculated to continue and threaten an impending fertility crisis (Aitken, 2024 p.1). However,. microplastic exposure is something that has steadily increased in the past 50 years and if it is impacting sperm counts as well as causing health issues it is an issue that needs to be addressed on a wide scale. As previously discussed, due to its prevalence in the biosphere, the controls any one individual can implement to prevent their exposure are extremely limited and hence it is not an issue that we can expect to be tackled by being left to individual control.

3.4 Impact of microplastics on female fertility and reproduction

While the impacts of microplastics on sperm count and the male reproductive organs are concerning, they are only one half of the equation of human fertility and reproduction. When understanding the impact of microplastics on female fertility and reproduction we are engaging with an understanding that any toxic impacts of microplastics present, can be impactful not only to the female's health and fertility but also the health of any current or future offspring she may choose to have. This is confirmed, as we know that microplastics "tend to elicit multiple reproductive consequences in a variety of organisms, leading to the decline of female fertility and the developmental anomalies of offspring." (Geng et al 2023, p.8). Again, as with the developing research on the impact of microplastics on male fertility and reproduction, Geng et al's research model is not based on humans, however as previously discussed the pattern within microplastic impact on mammals tends to repeat when tested on humans.

In researching the impact of microplastics on the reproductive system Hong et al reports that "In addition to their carrier role in the transport of other pollutants, MPs and NPs

always enhance the toxic effects of their attached materials in many organs " (Hong et al 2023, p.11) It is important to note that, the enhancing effect that microplastics have on the toxic elements of their attached materials, confirms that these substances are not just bioaccumulating in our organs, but they are having heightened toxic impacts upon them. Given the potential of microplastics to induce heightened toxicity, this has implications for the reproductive capacity of the female reproductive organs. Additionally, given Ghosh et al's previous findings that microplastics disrupt hormones we must give consideration to the possibility that any detriment to women's reproductive organs has the potential to impact the hormone cycle that is controlled by these reproductive organs. It is well established that disruption of the female reproductive hormones can have drastic impacts on women's overall physical and mental health and well-being. (Druckmann, 2001 p.74)

Microplastics not only damage physically but chemically and can cause chemicals such as BPA to "be released in large quantities from certain polymers into the organism" (Li et al 2023, p.4). While this paper is limited to the specific toxic effects of one particular chemical compound that can be released into the body by microplastics (albeit under simulated gastrointestinal conditions), it is especially relevant in the emerging field of assessing microplastics' influence on female reproduction. Chemically BPA is very similarly shaped to oestrogen hence when released within the body it can have a blocking function, binding to oestrogen receptors, thereby taking up space meant for oestrogen and then impacting the functions normally regulated by oestrogen. (Liu et al, 2018 p.6793).

Additionally phthalates released by microplastics have been associated with causing birth defects and are implicated as potential carcinogenic chemicals. (Erkekoglu, 2014 p.617) Therefore the release of endocrine disruptors such as BPA and phthalates by microplastics is highly concerning, as it means that these tiny particles which can be consumed without our knowledge can have hugely detrimental impacts on our well-being and ability to produce healthy offspring.

This research further adds to the alarming trend which is evident when reviewing health and medical research on microplastics; potential concerns predicted in research papers tend to be confirmed or even confirmed to be worse than originally hypothesised in following research within a very short window of time.

The concerning impact of microplastics on female health and human fertility is identified by Ragusa in "the first study revealing the presence of pigmented microplastics and, in general, of man-made particles in human placenta" (Ragusa et al 2021, p.5). As placental quality has direct implications for foetal health, this early paper hypothesises that

we are confronting a problem that affects not only the global population today, but potentially a global health issue for generations to come, as developing humans are being exposed to microplastics even before they are born. This research is quickly followed by that of Liu et al which confirms the presence of "various kinds of MPs in placentas, meconium, infant feces, breast milk, and infant formula" (Liu et al 2023, p.8) It is of particular importance to note the presence of microplastics in the human placenta and meconium (or the newborn infants first bowel movement), as not only does it confirm the pattern of human research models reflecting earlier animal research models, but more importantly, it confirms just how acute and severe the threat of microplastic pollution is to human health, as we are exposed to it even before birth. The placenta as an organ is specialised for protection, it has evolved to protect the foetus and perform the function of organs as the foetus develops. Regulating hormones and acting as the gut, lungs, and kidneys for the foetus; the placenta is integral for foetal development. It protects the foetus from maternal disease, infections and even can protect against some environmental toxins, however as this research revealed this protection does not extend to defending against the novel threat of microplastics.

As with the findings in male reproductive health and fertility, the findings here confirm the pattern that the detrimental effect of microplastics on female fertility and offspring health in non-human research models, are later replicated and confirmed in human studies.

Given the extensive research outlining the damaging and toxic effects of microplastic pollution on the developed body with an established immune system and regulated hormones, the effects that such damage might have on the developing foetus, especially at the most vulnerable and formative stages are of great concern.

The evidence gathered from the research and analysed in this chapter effectively answers the first two of the three key questions presented in this thesis. We can see from the rapidly developing and strengthening evidence in the field of science and medicine, that microplastics do indeed have an impact on health and well-being. Furthermore, from studies undertaken first with animals and later with humans, we can also confidently assert that microplastics do have an impact on fertility and reproduction.

Having answered these two questions we are then confronted with the third key element of the thesis, which poses the question - Do microplastics pose a potential threat to human rights?

The evidence from the field of medicine and science has introduced the concept that due to the insidious nature of microplastic pollution, humans are being subjected to the

harmful impacts of microplastics without their knowledge or consent, and in a way where they have little, if any, personal agency. This raises concerns about freedom of choice in terms of health and well-being. While there are some toxins we can choose to expose ourselves to, with some awareness of the impact they may have on our health or fertility, this is not so in the case of microplastic pollution. The rapidly developing information on the effects of microplastics is not being sufficiently provided to people to enable informed choice about their own health and wellbeing. Furthermore, the ubiquity of microplastic pollution in the environment limits peoples' ability to have access to safe microplastic-free choices. This lack of freedom of choice is further exacerbated when considering the potential impact it has on fertility, reproduction and future generations.

To address the third research question and explore how this evidence from the field of medicine and science might intersect with the concept of Human Rights, we now turn our attention to the field of Environmental Justice.

I have chosen environmental justice as a theoretical lens through which to examine this intersection, because although the literature search for the Human rights implications of microplastic pollution produced very limited results indicating a literature gap, environmental justice provides a solid theoretical foundation of an intersection between human rights and more general pollution.

4.Environmental Justice

4.1. Development of theory

Environmental justice as presented by Robert Bullard "embraces the principle that all communities are entitled to equal protection of environmental, energy, health, employment, education, housing, transportation, civil, and human rights" (as cited by Christensen, 2022). As a concept Environmental Justice began to take root politically especially in disenfranchised communities across the United States in the 1970s and 1980s (Bullard 2005, p.7). One such community was in Houston where Bullard became a key witness in the Bean v. Southwestern Waste Management, Inc. This was a case in which the choice of the location of a dumping site was challenged for having no other reason to be located in the middle-class neighbourhood, other than it being made up of over 80 percent African American residents. Bullard's collection of data was key to understanding the case highlighting that "three of the four privately owned landfills, that were used to dispose of Houston 's garbage, were located in African American neighborhoods. Although African Americans made up only "28 percent

of Houston's population, 82 percent of the solid waste sites [public and private) were located in African American neighborhoods." (Bullard 1992, pp.11-12) This was the first case to challenge the siting of a waste facility using a civil rights argument (Bullard 2005, p.19) The relationship between the environment, rights and justice is an intertwined one, as highlighted by this case. Scholars of environmental justice such as Beverly Wright, Olga Polmar and Robert Bullard understand environmental destruction and threats as occurring not in parallel, but within, the context of systemic injustices. They argue for example that racism leads to environmental injustices and environmental racism (such as the legal case described above) and therefore necessitates the enactment of environmental justice.

In Bullard's 1992 work, *In our backyards,* he collates his findings on the multiple incidents of environmental injustices which he observed. He described the mechanisms underlying such injustices as environmental racism are and outlined their impact. This work became formative in the development of the theory of environmental justice. This theory is explored further at a global level in his 2005 work *The quest for environmental justice: Human rights and the politics of pollution* (Bullard, 2005) which has relevance to the consideration of the global scale of the issue of microplastic pollution.
Within this book Bullard discusses the consensus amongst activists and scholars in the 1990s that

> *environmental justice has to be a top priority in the twenty-first century. Despite improvements in how the government addressed environmental protection, gaps persisted. Communities were faced with the steady chipping away of civil liberties, basic civil and human rights, and environmental and health protection*
>
> Bullard 2005, pp. 24-25

The preferred strategy of the environmental justice movement is the adoption of the public health model of prevention; thereby focusing upon the elimination of a threat before harm occurs (Bullard 2005, p.26). It also stresses the need for protection, incorporating the principle that "all individuals have a right to be protected from environmental degradation"(Bullard 2005, p.25).

The core ideas of prevention and protection are integral to the principles of environmental justice. A set of seventeen principles, that provide a framework to tackle environmental injustices, were derived from the foundational values which underpin

environmental justice. These principles aim to ensure equity, recognise diversity, promote sustainability, address environmental health issues, empower communities and advocate for human rights, understanding environmental justice as requiring action on multiple levels from individual and community action and sustainability all the way up to multinational corporations, states, and global treaties. These principles of environmental justice address environmental issues alongside the co-existing social issues such as employment, health, housing, and culture that are directly impacted by them. (Bullard 2005, p.299).

4.2. Relevance

The relevance of Bullard's Environmental Justice theory to the issue of microplastic pollution is significant, as it provides a framework for understanding not only the effects microplastics have as a pollutant to the environment, but also the effects that they have socially and on human well-being and rights. This theory is of particular importance when it comes to the analysis of the effects of microplastic pollution, because it allows for analysis of the global dynamics that are impacted by pollution, as Bullard argued "While the Bamako and Basel conventions may have made certain dumping formally illegal, in practice they have not prevented the transboundary movement of hazardous waste to developing countries" (Bullard, 2005 p.285). He thereby raised awareness that the effects of global pollution extend beyond specific protected groups, areas or actions as conceived in historical conventions and therefore require to be considered in a global context.

Understanding the impact of transboundary movement of hazardous waste and pollutants is of particular importance in the case of microplastics due to their size and hence transportability in water, soil and air which is of major concern to many rights including our right to breathe clean air (Bullard, 2005 p.34)

The choice of environmental justice as a framework for analysis, is also suitable to bridge the research gap identified in the literature explored in this thesis. This gap concerns the impact that microplastic pollution has on human rights, specifically through its effects on human health, well-being, and fertility. Bullard identified back in 2005 that "25 percent of preventable illnesses in the world are directly caused by environmental factors" (Bullard, 2005 p.281) and this statistic has remained broadly stable with WHO reporting that 24.3% of global illness is attributable to the environment. (WHO, 2016). To build on existing research and address the research gap that exists between microplastics and human rights, it

is beneficial to adopt a theoretical understanding that has already established health as important in terms of environmental destruction. Environmental justice theory outlines that environmental destruction is not only detrimental in and of itself for individuals, but also as a part of a wider cost beyond just loss of usable land. "As of 2015 in the USA alone the health costs of disease and disability caused by the plastic-associated chemicals PBDE, BPA and DEHP exceeded $920 billion "(Landrigan et al, 2023 pp.3-4)

One of the key benefits of environmental justice as a theory, is that it invites us to explore not only the data relating to microplastics' impact on human rights, but allows us to consider the underlying system which enables the problem of microplastic pollution to exist. Scientific papers on the biological interactions and health impacts of microplastics are informative as to establishing '*the what*' of microplastics pollution; what the threat of microplastics is, what the effects are on the biosphere. In parallel, the framework of environmental justice allows us to elevate our understanding and also examine '*the why'* of microplastic pollution; why pollution is profitable, why it is political, why it persists. This understanding of the power dynamics involving finance and economics, all the way up to a global scale, is important in pursuing environmental justice. The principles of environmental justice could be utilised to challenge global environmental injustices such as microplastic pollution through the pursuit of "equal environmental protection, vigorous enforcement of human rights, and a reduction of the growing gap between rich and poor nations."(Bullard, 2005 p.294)

The framework of environmental justice highlights the importance of all rights being met and the problems, such as the severe health consequences, that can arise as a cost of disregarding certain rights or the rights of certain groups as less important. This framework highlights the importance for "governments not only to guarantee civil and political rights but also to guarantee economic, social, and cultural rights."(Bullard, 2005 p.294), confirming a link between the theory of Environmental Justice and human rights treaties such as The International Covenant on Economic, Social and Cultural Rights (ICESCR, 1966).

The combination of an understanding of justice, rights, and political/economic systems, with regard to the environment, its protection and destruction, which is offered by this theory of Environmental Justice provides the best available framework for bridging the research gap between

microplastics and human rights. This is reflected in recent reports that confirm that the

> *adverse effects of plastics and plastic pollution on human health, the economy and the environment are not evenly distributed. They disproportionately affect poor, disempowered, and marginalized populations such as workers, racial and ethnic minorities, "fenceline" communities, Indigenous groups, women, and children, all of whom had little to do with creating the current plastics crisis and lack the political influence or the resources to address it. Plastics' harmful impacts across its life cycle are most keenly felt in the Global South, in small island states, and in disenfranchised areas in the Global North*.
>
> Landrigan et al, 2023 p.4

The inequality highlighted above by Landrigan et al confirms the framework established by Bullard and other early scholars of environmental justice, who understood that to solve the problems we face with environmental pollution, we need to go beyond just alleviating the symptoms of this crisis as they arise. We must address the underlying systems of inequality that impact the way pollution occurs in the first place. "A significant reduction of inequities-among nations, within nations, between racial and ethnic groups, between social classes, and between men and women would go a long way toward creating just, healthy, and sustainable societies for all." (Bullard, 2005 p.294).

Scholars of environmental justice understand environmental destruction as needing to be tackled at its root cause, arguing that it is not enough to merely respond to the symptoms of pollution after it occurs, but we must ensure systems are redesigned to guarantee rights, equality, justice and prevent these problems reoccurring, alongside addressing their consequences.

Bullard identifies that environmental racism is not only limited to a state-wide level but is an international problem, with the global norths' disregard for the impact of pollution from their profits on the global south being evident in the leaked quote from the then chief economist of the World Bank, Lawrence Summers who wrote "Dirty Industries: Just between you and me, shouldn't the world bank be encouraging MORE migration of the dirty industries to the LDCs (less developed countries)?" (cited in Bullard 2005, p.285)"

This potentially provides an answer as to why the problem of microplastic pollution was able to reach such levels of ubiquity in our environment and become a problem for global health and human rights. The global financial system that has been built for prioritising profit and shipping off the toxic consequences of the pollutants of such industry and trade to communities and states of less wealth, unable to defend themselves against it or unable to refuse the financial incentives offered. In a system built in such a way that profit is the goal, and accountability, and sustainability are directly avoided, the problem of plastic pollution was assumed to follow the trend of other pollutants, i.e that it would impact the citizens of the countries to which we outsource the labour, and be out of sight and mind for wealthy western consumers. However, due to plastics' unique nature as a pollutant it persisted, broke further down into micro and nanoplastics and spread around the globe. Now, a system that barely supports the course of justice and accountability for the environment and pollution in small, clear cut, isolated and enclosed cases, must answer for the cause and solution to a global issue that poses the threat of impacting all of humanity as well as generations to come. There is a clear responsibility for richer countries to reduce their consumption and invest in solutions (Boeker & van Grondelle, 2000 p.92).

The creation and lack of accountability for the problems of microplastic pollution directly flies in the face of most of the principles of environmental justice as illustrated below.

Principle 1 of Environmental Justice affirms " the right to be free from ecological destruction." (Bullard 2005, p.299) This is violated by the destructive impact of plastic and microplastic pollution on the environment.

Principle 3. "Environmental Justice mandates the right to ethical, balanced and responsible uses of land and renewable resources in the interest of a sustainable planet for humans and other living things. "(p.299). While plastics are useful and cheap to produce, they are not biodegradable, limited in their ability to be recycled and are often single use and hence are not only damaging but also not sustainable.

Principle 4. "Environmental Justice calls for universal protection from...disposal of toxic/hazardous wastes and poisons...that threaten the fundamental right to clean air, land, water, and food"(p.299) As outlined previously, microplastic pollution threatens our airways, waterways and food chain and protection from their toxic effects is required especially in our vital resources.

Principle 6. "Environmental Justice demands the cessation of the production of all toxins, hazardous wastes... and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production. (p.299)

Principle 9. "Environmental Justice protects the right of victims of environmental injustice to receive full compensation and reparations for damages as well as quality health care. "(p.299)

Principle 12. "Environmental Justice affirms the need for urban and rural ecological policies to clean up and rebuild our cities and rural areas in balance with nature"(p.299)

Principles 6, 9 and 12 above highlight the importance of practical action in solving the issues that arise from microplastic pollution. There needs to be immediate accountability on an international level, which will facilitate and support the other immediate needs for reparations, treatment, and clean-up efforts.

While Principle 17 of environmental justice acknowledges the requirement for us as individuals to "make personal and consumer choices to consume as little of Mother Earth's resources and to produce as little waste as possible; and make the conscious decision to challenge and reprioritize our lifestyles to ensure the health of the natural world for present and future generations"(p.299), addressing the impact we can have as individuals, there is also the acknowledgement of where the real power lies.

Principle 14. " Environmental Justice opposes the destructive operations of multi-national corporations. "(p.299).

Principle 10. " Environmental Justice considers governmental acts of environmental injustice a violation of international law, the Universal Declaration On Human Rights, and the United Nations Convention on Genocide. "(Bullard 2005 p.299)

There is a clear recognition as highlighted in principles 10 and 14 of the role that states and corporations have, in taking responsibility for addressing the problems they have caused to the people and planet they depend upon.

This paper only seeks to establish if and to what level microplastics are a threat to human health, well-being, and reproduction and hence human rights. While it does not extend to how the problem of microplastic pollution should be solved if it exists, it is useful

to be aware of the requirements which the Environmental Justice framework proposes for beginning to redress these inequalities, as this points to the possibility that solutions exist. These requirements include "that all governmental policies and practices adhere to the principles of the Rio Declaration on Environment and Development, in particular Principles 15 and 16 that mandate the precautionary approach and the polluter bearing the cost of pollution"(Bullard, 2005 p.296)

The necessity for global cooperation to promote equality by bearing the cost of pollution is again mirrored in more recent reports, which highlight that there is a requirement for a "reversal of these inequitable burdens to ensure that no group bears a disproportionate share of plastics' negative impacts and that those who benefit economically from plastic bear their fair share of its currently externalized costs" (Landrigan et al, 2023 p.4). The repetition of Bullard's ideas within contemporary research strengthens the applicability of environmental justice theory, to the field of microplastic pollution. The contemporary discourse as outlined by Landrigan et al, confirms the persisting requirement for protective and preventive action to be taken, and for solutions to the problems presented by plastic and microplastic pollution to be found.

4.3. Limitations

While proposing that environmental justice is the theory of 'best fit' against which to test the thesis that microplastic present a human rights challenge, there are limitations to this theory that are important to understand especially regarding the topic of microplastics. Microplastics are a relatively new and niche area of research, hence there are not a wide range of theories that are completely applicable to this research niche. While Environmental Justice provides a good framework to begin to understand microplastic pollution, it must be acknowledged that when ideas of environmental justice began to be discussed and formulated, there was very little understanding of microplastic pollution as an issue. However, microplastics now exist as a unique pollutant, seemingly reaching a scale which few pollutants have ever been able to in the past. Adding to this unique status, there are a complex combination of many sources globally from which microplastics originate (including production, cosmetics, weathering of plastics, shedding of plastic fibres amongst many others), unlike other cases of environmental destruction or pollution that are the responsibility (even if shirked) of a single corporation or state. These unique features as a pollutant, as well as the ubiquity and scale of microplastic pollution, in combination with a lack of specific legislation addressing it as an issue and the

lack of education and awareness on a global scale make it a unique case when analysing its effects. Therefore, it cannot be expected that any previously framed theories would adequately address all the unique characteristics of microplastics. However, with these limitations in mind Environmental Justice presents the most appropriate theoretical framework through which to analyse the potential effects of microplastics on human rights.

Some of the issues which arise within the environmental justice field, such as pollution affecting some communities more than others, may seem less applicable in the case of microplastics due to their ubiquity and the scale of microplastic pollution. While it is important to acknowledge this limitation and be aware of it when applying the theory to this unique pollutant, (as it prevents a complete overlap between this topic and the chosen theory), this does not mean that the theory becomes invalid. While microplastics may represent a closer to equal level of exposure to a pollutant globally than has potentially ever existed before, in that it is a threat to all regardless of race, class, gender, income, age or nationality, does not mean all are necessarily being exposed at the same rate. Furthermore, its ubiquity does not negate the imbalances that are impacted by these factors, in terms of access to lifestyle and healthcare choices that mitigate risks to health.

Environmental justice theory establishes a firm link between environmental pollution and a threat to human rights, which is required to begin to address the third and final key question of this thesis: *Do microplastics pose a potential threat to human rights*? Therefore the theory of Environmental Justice provides a useful lens through which to examine the factors that are at play on a wider global scale which allow for the problem of microplastic pollution to exist and persist.

5.Human Rights

5.1 *Comparative cases*

Having established that microplastics are not just a harmless man-made contribution to our planet but pose a real and significant threat to the biosphere as well as human health, well-being and reproduction, we can then begin to observe how that threat can be understood sociologically as well as biologically, through the examination of comparative cases.

To gain a sociological understanding of the way pollution affects people and is dealt with, through permission and denial or punishment and accountability, it is useful to observe how it manifests in other cases. The case of the Love Canal incident was an environmental disaster that occurred in the 1970s in Niagara Falls in New York. A neighbourhood was built

on the dumping site of tons of toxic chemicals that caused the residents to suffer from a variety of health issues including epilepsy, miscarriages and crib deaths that stemmed from the effects of long-term exposure to this hazardous waste. Like many cases of pollution there was initially very little government intervention or response to take accountability, and only after the extensive labour of self-advocacy from the residents, resulting in surveys, protests, but most importantly media coverage, was there finally any action from government. The action ultimately led to a relocation of residents and clean-up of the area (Hay 2009, p.111).

This case adds to the understanding of the impact of pollution on communities, especially the impact of long-term exposure to toxic pollutants on well-being and reproductive/infant health, which has parallels with the risks identified in the literature on microplastics. It is also informative as to the challenges of achieving accountability and state action in cases of pollution, becoming as it did, a pivotal case in the formation of environmental regulations and beginning of clean-up efforts. However, it also highlights the general pattern of avoidance of accountability in pollution cases, despite the courage of whistleblowers and citizens seeking protection for their rights, and even when the pollution causes extensive and long-lasting health and reproductive problems. This case also shows that what is considered sufficient grounds to intervene, act and protect people, is much more complex than might be assumed. For example, the case illustrates that how image and arguments are presented, holds great weight, as was discovered by the residents who,

> *initially tried to argue for state intervention based upon their status as property owners, a status mostly ignored by elected officials. The arguments residents then made for relocation based on heterosexual reproduction displayed a new understanding of their relationship to the state as one demanding the protection of the traditional nuclear family*
>
> Hay 2009, p.127

Another comparative case which supports the link between the impact of microplastic pollution and human rights is the case of global tobacco. The human rights strategies that were used to promote global tobacco control and address the associated questions of social and human rights, have applicability to the issue of microplastic pollution. While initially it may seem an unrelated comparison, due to tobaccos use as a voluntary recreational drug compared to the almost universal use of plastics in everyday life, when

observed further, the parallels especially in terms of understandings of global health and human rights are revealing. The themes of health education, information, free choice, safe alternatives, and well-being over profit, emerge here as relevant in both cases. While there were huge profits being made via the tobacco trade, states and international governing bodies still had the obligation to listen to, acknowledge and act upon the relevant scientific health research of the time, which was exposing the negative health impacts of tobacco consumption.

There is relevance to the microplastic debate in the case of tobacco control, not only by undermining the argument that profit should take precedence over people's health and rights, but also in the protection of the vulnerable, the creation of safe spaces and the importance of international cooperation and control, especially when human rights are used effectively as a framework to improve safeguarding of global health. Regardless of the potential for governments to gain financially from the influence of the tobacco lobby, states which ratified human right treaties were obligated to "protect the rights of their citizens to life and health, [and] should be required to adopt legislative or other measures to ban tobacco advertising, discourage consumption of tobacco products, and ensure smoke-free workplaces and public spaces." (Crow 2004, p.221).

This shows the importance of state intervention and control in the name of protection of its citizens, not only by ensuring that the safe freedom of choice could be expressed, exercised and enjoyed by those who choose not to smoke, but also by protection of the rights of those who choose to smoke. Even for those who choose to smoke, there is also a responsibility for the authorities within that state to ensure that the risks of that choice are somewhat mitigated through regulation of substances within tobacco products. There was the responsibility not only to educate the citizens on the relative risks of the choices being made, but to actively engage with private companies and regulate tobacco production because "under international law, states are also responsible for human rights violations perpetrated by private companies" (Crow 2004, p.224).

While the relevance of the smoking regulations case to the issue of microplastic pollution may not be immediately obvious, one significant parallel provided by this case is that human rights concerns which are caused by a polluted environment can be challenged even when this might cause significant financial losses, therefore the tobacco case may potentially be used to challenge the financial case for continued production and use of plastics. With this context in mind, we can see that when debating the issue of

global microplastic pollution, it would be difficult to sustain the argument that the pollution and its side effects are justifiable due to financial pressures of the profits that would be lost if a change to a material safer but more expensive than plastic was required. The financial argument is further undermined if we include the considerable cost incurred by not only the environmental but health impacts of plastics, as of 2015 in "the USA alone the health costs of disease and disability caused by the plastic-associated chemicals PBDE, BPA and DEHP exceeded $920 billion." (Landrigan et al 2023, p.4). This data is relevant as it highlights the impact of plastic pollution on not only the environment but also human health, the economy and social justice. While the data presented by Landrigan et al is not limited to microplastics but refers to plastic pollution in general, it is still highly informative and relevant, both in the provision of current statistical data but also the underlying principle of calculating the true cost and burden of plastic pollution.

With the wealth of emerging evidence illustrating the threat to human health and fertility that microplastic pollution poses on a global scale, it can be argued that states have a responsibility to act upon that information, to both inform and protect their citizens. People need to have the freedom to make informed choices on their own health and well-being and that of their families. This needs to be done by ensuring there is sufficient information and education on the negative potential of microplastics on human health. As was the case in the development of smoking regulations, this must also be done by protecting both those who choose to take protective action as well as those who do not. We need therefore, to educate on the harmful effects of microplastic exposure and protect those who want to avoid plastics as well as the vulnerable and those unable to consent. This is done by creating spaces for alternative safe choices and the information to allow for these choices to be free and informed. We can draw some guidance about how we might approach this from the precedent set by the tobacco regulation case as outlined below.

When addressing the emerging evidence of the risk to health among passive smokers, many governments devised a system of 'opt in' rather than 'opt out', meaning that a rolling ban on smoking was gradually established in schools, hospitals, restaurants, transport and finally public places and spaces, so that those who choose to smoke can go outside or do it in their own homes; they are free to enjoy their choice, but not at the cost of the health of others. At one time such a blanket prevention of exposure to environmental harm through passive smoking was considered both impractical and unworkable. Now however, the expectation that non-smokers should be obliged to suffer

the harmful effects of others choices is but a memory in almost all public spaces where no one is any longer forced to breathe in the smoke of others. Perhaps the equivalent and seemingly insurmountable health challenge of microplastics can follow a similar course through the application of human rights legislation. As was the case for global tobacco the capacity for individuals to express their free and informed choice to limit their exposure to the dangers posed by air pollution This would require upholding the freedom of choice for individuals by holding accountable states, companies, organisations or people who undermine or prevent the exercising of such freedoms (by polluting or covering up their contributions to pollution), and hence undermining the ability of an individual to exercise and engage in free and informed choice. Individuals do not have the power to protect themselves from the actions of international actors or companies and hence there is a framework of international rights and justice to protect, ensure and uphold such rights, but it is a framework that must be applied for it to be effective.

A further relevant comparative case to be considered is that of the threat to global security which is presented by the broader issue of plastic pollution. While this is inclusive of microplastics, it is not exclusive to microplastics, applying as it does to large scale plastic pollution. The global security threat which arises from broader plastic pollution is due to its destructive environmental impact on the ecosphere upon which we all rely, threatening our very survival. Therefore the idea that plastic pollution is a threat to not only the environment, human health and rights but also global security is difficult to refute. While observing international cooperation in the face of global challenges, when compared to issues such as biodiversity, climate change and even illegal/unregulated fishing, there is a lack of similar action when it comes to plastic pollution, despite the fact that it “meets the same criteria and, in many cases, feeds existing threats to security such as climate change and biodiversity loss which are already considered major threats to human survival." (Dubois 2021, p.23). Again, while Dubois’ paper isn't solely about microplastics, it does mention them in the wider context of the issue of plastic pollution and highlights the lack of specific legislation on this issue and how pollution on this scale is a global problem and even a threat to global security.

Microplastic pollution poses a unique, ubiquitous, and pressing threat to the environment, human rights and global health, and cannot be solved by expecting regulations on other issues to encapsulate and remedy this too. This is evident in the continuing prevalence of microplastic pollutions as a threat despite the existence of regulations on other issues.

The analysis of the comparative cases as presented in this chapter provides a precedent which allows us to understand practical examples of environmental pollution and global health within a rights framework. This lays the foundation for applying a human rights framework to the issue of microplastic pollution in preparation to answer the third research question, *Do microplastics pose a potential threat to human rights?*

5.2 Impact of microplastics on human rights

Embedding the issues of microplastic pollution within a legal framework of human rights provides us with a number of avenues through which we can understand the threat that microplastics pose, not only to the environment and global health, but also consequently to human rights.

Article 25 - ‘standard of living adequate for the health and well-being of himself and of his family’ (UN General Assembly, UDHR, 1948)

The evidence shown of the threat of damage posed by the toxic effects of microplastics combined with the essentially inescapable nature of their ubiquity, means that individuals are facing a threat to their health and well-being. This threat is further exacerbated by a lack of available information from their states on the dangers or the protection of safe alternatives to allow for informed free choice. This is true not only for the individual but also their family. The relevance of this article is clear due to the impact that microplastic pollution has on health and well-being, and the ability it has to affect people around the globe. Article 25 is well established and is legally binding and ratified by a higher number of states(192), than some of the other articles (CEDAW-189 states, ICESCR-172 states) which we will consider below. (UN as of 2024)

Article 10 - ‘Special protection should be accorded to mothers during a reasonable period before and after childbirth’ (UN General Assembly, ICESCR, 1966)

The vulnerability of the developing foetus and the mothers carrying them has been outlined in the evidence of the toxic effects of microplastic exposure and evidence of microplastics in breastmilk, meconium, and the placenta. Microplastic pollution represents a high threat to health and well-being, especially at this vulnerable stage for both mother and foetus that indicates a general lack of safeguarding

and especially highlights a lack of the *special protection* as envisaged in article 10. Article 10's relevance to microplastic pollution is somewhat more tenuous than that of Article 25 of the UDHR, as it does not explicitly dictate that this protection should extend to protection of the mothers' health from environmental factors. However, in the context of understanding the impact of microplastic pollution on fertility and reproduction as well as general health, there is a potential threat here. The rights outlined in article 10 only apply from birth, hence the impact to the foetus isn't a separate violation as all potential violations of rights to health and well-being begin at birth.

Article 12 - 'right of everyone to the enjoyment of the highest attainable standard of physical and mental health.' (UN General Assembly, ICESCR, 1966)

Article 12 here holds a similar relevance to article 25 of the UDHR but demands a higher threshold. If, as argued above, Article 25 is undermined at a level that is deemed inadequate, then a level that is considered the *highest attainable*, as envisaged within Article 12 , is definitely undermined. The limitations posed to an adequate standard of ensured health and well-being, as highlighted in the threat posed to article 25 of the UDHR, is only further confirmed here. The significant threat of damage and toxicity from microplastics to human health is absolutely a threat and a prevention to humans around the globe enjoying the "*highest attainable standard of physical and mental health"*

Article 16(E) - The same rights to decide freely and responsibly on the number and spacing of their children and to have access to the information, education and means to enable them to exercise these rights' (UN General Assembly, CEDAW, 1979)

The threats that microplastic pollution pose to fertility and reproduction present issues here. If individuals are being exposed to harmful chemicals that impact their fertility and ability to reproduce, without their knowledge, or are not being provided with access to safe alternatives, then the ability to freely decide how many children they have is called into question. Importantly, there is within this article specific reference to the key importance of *education and means* to *exercise these rights*, which is severely lacking when it comes to microplastic pollution.

The human rights council outlined the Human Right to a Clean, Healthy and Sustainable Environment in 2021.Within this document it

> "1. Recognizes the right to a clean, healthy and sustainable environment as a human right;
>
> 2. Notes that the right to a clean, healthy and sustainable environment is related to other rights and existing international law;
>
> 3. Affirms that the promotion of the human right to a clean, healthy and sustainable environment requires the full implementation of the multilateral environmental agreements under the principles of international environmental law;
>
> 4. Calls upon States, international organizations, business enterprises and other relevant stakeholders to adopt policies, to enhance international cooperation, strengthen capacity-building and continue to share good practices in order to scale up efforts to ensure a clean, healthy and sustainable environment for all"

(Human Rights Council 2021,p.3)

This resolution arguably holds a lot more relevance to the topic of microplastic pollution than some of the previous articles, however as it is only a resolution, it is merely a formal expression of the opinion of the United Nations and not legally binding, therefore it is limited in this regard. Nonetheless, the connection between this and the research question is clear, as microplastic pollution poses a threat to the right to *a clean, healthy, and sustainable environment for all*. These actions suggested by the human rights council are required to be implemented immediately and internationally as a first step toward a solution to the problems caused to the environment, global health, and human rights by microplastic pollution.

6.Conclusion

The issues presented to humans and the planet we inhabit by microplastic pollution are clear even from the emerging evidence in this nascent field of research. There are however limitations in the collection, presentation and analysis of the issues presented within this paper. One of the issues with novel research and emerging research fields is a limitation in terms of reliability of even the most valid research, due to a lack of continuous proven

repeatability of findings over the longer term. While I aimed to gather as many relevant findings as were available, given that this is a rapidly growing field of research, the reliability of a thesis such as this could potentially be even stronger in as little as a few more years, as research emerges and strengthens the understanding within this field.

Similarly, there are limitations in terms of a sociological analysis, again due to a gap in the literature. The challenge of microplastic pollution is not yet something that has been widely discussed through sociological lens or human rights framework, therefore I had to rely on the analysis of wider forms of pollution and more generalised threats to global health, to inform my understanding of the place microplastics holds within the sociological framework.

Finally, there are limitations, not only in terms of external validity of research, but also in the internal validity of the research process. I was cautious throughout my research to be aware of only basing my thesis on actual findings, not extrapolations or hypotheticals regardless of their high likelihood. In addition to this, I undertook extensive research for any evidence of a null-hypothesis or counter findings to my thesis, and was unable to find any.

Despite all these limitations, which are unavoidable when one engages with the limited literature in the early stages of a new field of research, I have been able to draw together multi-disciplinary threads from the disparate fields of medical science, sociology, and human rights, to analyse and synthesise their significance to my research questions and present a coherent argument. My thesis does not contradict existing research, rather it confirms a pattern emerging from the literature, that pollution threatens global health and human rights. My thesis then connects this emerging pattern to the nascent research in the field of microplastics. Through this coalescing of the evidence gathered from the literature, I observed that on a global scale we have failed to take proactive, preventative or precautionary action against this pattern of threats in line with the established principles of environmental justice. Therefore microplastics have repeated this pattern and we now know that they also represent a unique threat to our health and well-being, potentially on a scale greater than any other known pollutant.

I believe I have achieved my aims and outlined the threat that microplastic pollution poses to health, well-being, fertility and reproduction and furthermore have successfully illustrated how and to what extent microplastics do in fact pose a threat to human rights. This paper does not, however, fill the gap between the fields of microplastics and human rights, it is merely an early contributor. There are many areas of further research needed, not only into the specific human rights issues as outlined above, but also into the potential threat

microplastic pollution presents in terms of rights to clean water, food and even adequate housing, given its contributing role to climate change.

7. Bibliography

Aitken, R.J., 2024. What is driving the global decline of human fertility? Need for a multidisciplinary approach to the underlying mechanisms. *Frontiers in Reproductive Health,* 6, p.1364352.
Available at:https://www.frontiersin.org/articles/10.3389/frph.2024.1364352/full

Andrady, A.L., 2017. The plastic in microplastics: A review. *Marine pollution bulletin,* 119(1), pp.12-22.
Available at:https://doi.org/10.1016/j.marpolbul.2017.01.082

Boeker, E. and van Grondelle, R. (2000) 'The environment as a human right', The *International Journal of Human Rights*, 4(1), pp. 74–93. doi: 10.1080/13642980008406860.
Available at:
https://www.tandfonline.com/doi/epdf/10.1080/13642980008406860?needAccess=true

Boyd, D.R. (2023) UN experts warn of "Toxic tidal wave" as plastic pollutes environment and threatens Human Rights | Ohchr.
Available at:
https://www.ohchr.org/en/press-releases/2023/06/un-experts-warn-toxic-tidal-wave-plastic-pollutes-environment-and-threatens
(Accessed: 22 May 2024).

Brachner, A., Fragouli, D., Duarte, I.F., Farias, P.M., Dembski, S., Ghosh, M., Barisic, I., Zdzieblo, D., Vanoirbeek, J., Schwabl, P. and Neuhaus, W., 2020. Assessment of human health risks posed by nano-and microplastics is currently not feasible. *International Journal of Environmental Research and Public Health,* 17(23), p.8832.
Available at https://www.mdpi.com/1660-4601/17/23/8832/pdf

Bullard, R.D., 1992. In our backyards. EPA J., 18, p.11-12
Available at:https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=4000083P.TXT

Bullard, R.D. ed., 2005. The quest for environmental justice: Human rights and the politics of pollution (Vol. 19, pp. 32-33). San Francisco: Sierra Club Books.
Available at:https://archive.org/details/questforenvironm0000unse/page/n7/mode/2up

Carpenter, E.J., Anderson, S.J., Harvey, G.R., Miklas, H.P. and Peck, B.B., 1972. Polystyrene spherules in coastal waters. *Science*, 178(4062), pp.749-750.
Available at:
https://sci-hub.ren/https://www.science.org/doi/abs/10.1126/science.178.4062.749

Crow, M.E., 2004. Smokescreens and state responsibility: using human rights strategies to promote global tobacco control. *Yale J. Int'l L.*, 29, p.209..
Available at:
https://openyls.law.yale.edu/bitstream/handle/20.500.13051/6481/08_29YaleJIntlL209_2004_.pdf?sequence=2

D'Angelo, S. and Meccariello, R., 2021. Microplastics: a threat for male fertility. *International Journal of Environmental Research and Public Health*, 18(5), p.2392. Available at: https://www.mdpi.com/1016764

Danopoulos, E., Twiddy, M., West, R. and Rotchell, J.M., 2022. A rapid review and meta-regression analyses of the toxicological impacts of microplastic exposure in human cells. *Journal of Hazardous Materials*, 427, p.127861.
Available at:https://www.sciencedirect.com/science/article/pii/S0304389421028302

Dubois, C., 2021. Plastic Pollution Is a Threat to Global Security. Ocean Legacy, British Columbia.
Available at:
https://oceanlegacy.ca/tolf/wp-content/uploads/2021/11/Plastic-Pollution-is-a-Threat-to-Global-Security-FINAL.pdf

Christensen, K. November (2022) Environmental injustices still felt by many, says Robert Bullard
Available
at:https://factor.niehs.nih.gov/2022/11/feature/2-feature-robert-bullard#:~:text=%E2%80%9CEn%20vironmental%20justice%20embraces%20the%20principle,directs%20the%20Bullard%20Cen%20ter%20for
(Accessed: 22 May 2024).

Erkekoglu, P. and Kocer-Gumusel, B., 2014. Genotoxicity of phthalates. *Toxicology Mechanisms and Methods*, 24(9), pp.616-626.
Available
at:https://www.tandfonline.com/doi/pdf/10.3109/15376516.2014.960987?casa_token=XoxTX0dNMmwAAAAA:a-wK_Q73CmbFVuMvwZCHpreHgocS5_L59pB2Yy-WtshHmqZxiaN_G_7AwxEz_xnO5dZ5vZ8CQQGDGg

Geng, Y., Liu, Z., Hu, R., Huang, Y., Li, F., Ma, W., Wu, X., Dong, H., Song, K., Xu, X. and Zhang, Z., 2023. Toxicity of microplastics and nanoplastics: invisible killers of female fertility and offspring health. *Frontiers in Physiology*, 14.
Available at; https://www.frontiersin.org/articles/10.3389/fphys.2023.1254886/full

Ghosh, S., Sinha, J.K., Ghosh, S., Vashisth, K., Han, S. and Bhaskar, R., 2023. Microplastics as an emerging threat to the global environment and human health. *Sustainability*, 15(14), p.10821.
Available at https://www.mdpi.com/2071-1050/15/14/10821

Hay, A.M., 2009. Recipe for disaster: Motherhood and citizenship at Love Canal. *Journal of Women's History*, 21(1), pp.111-134
Available at:
https://muse.jhu.edu/pub/1/article/260026/pdf?casa_token=4FrKQOqHh6IAAAAA:Lu3PsX%20RG8Abcx9J4V1-pDU8-wzS1i20r1-U7BgXABQiFL5qAT9NI8YiueYPvDLfxCgscn1buwAc

Haque, F. and Fan, C., 2023. Fate of microplastics under the influence of climate change. *Iscience.*
Available at:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10475515/

Hong, Y., Wu, S. and Wei, G., 2023. Adverse effects of microplastics and nanoplastics on the reproductive system: A comprehensive review of fertility and potential harmful interactions. *Science of The Total Environment,* p.166258.
Available at:
https://www.researchgate.net/publication/373137944_Adverse_effects_of_microplastics_and_nanoplastics_on_the_reproductive_system_A_comprehensive_review_of_fertility_and_potential_harmful_interactions

Human Rights Council, The Human Right to a Clean, Healthy and Sustainable Environment, Res. 48/13, para. 1, UN Doc A/HRC/RES/48/13 (Oct. 8, 2021)
Available at:https://digitallibrary.un.org/record/3983329/files/A_RES_76_300-EN.pdf

Landrigan, P.J., Raps, H., Cropper, M., Bald, C., Brunner, M., Canonizado, E.M., Charles, D., Chiles, T.C., Donohue, M.J., Enck, J. and Fenichel, P., 2023. The Minderoo-Monaco Commission on plastics and human health. *Annals of Global Health*, 89(1).
Available at:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10038118/pdf/agh-89-1-4056.pdf

Leslie, H.A., Van Velzen, M.J., Brandsma, S.H., Vethaak, A.D., Garcia-Vallejo, J.J. and Lamoree, M.H., 2022. Discovery and quantification of plastic particle pollution in human blood. *Environment international,* 163, p.107199.
Available at: https://www.sciencedirect.com/science/article/pii/S0160412022001258

Li, W., Zu, B., Li, L., Li, J., Li, J. and Mei, X., 2023. Desorption of bisphenol A from microplastics under simulated gastrointestinal conditions. *Frontiers in Marine Science*, 10, p.1195964.
Available at:https://www.frontiersin.org/articles/10.3389/fmars.2023.1195964/pdf

Liu, S., Guo, J., Liu, X., Yang, R., Wang, H., Sun, Y., Chen, B. and Dong, R., 2023. Detection of various microplastics in placentas, meconium, infant feces, breastmilk and infant formula: A pilot prospective study. *Science of The Total Environment*, 854, p.158699.
Available at:
https://www.sciencedirect.com/science/article/abs/pii/S0048969722057989?casa_token=x13Hon%20yxhzsAAAAA:xvfNHxzPpjXHgCKIg_Xygkxbj_CPNJk2vXES_HyCe2BMVXm4Naz9KC8%20zMrAw2Mo_OadRSGL5r_8

Liu, Y., Qu, K., Hai, Y. and Zhao, C., 2018. Bisphenol A (BPA) binding on full‐length architectures of estrogen receptor. *Journal of Cellular Biochemistry*, *119*(8), pp.6784-6794.
Available at:https://onlinelibrary.wiley.com/doi/pdf/10.1002/jcb.26872?casa_token=HjFHK0rdx9YAAAAA:CRSVhDsZY-uynn38M4P_69r5Fy67_R-479WpxNWDazEQJe2U4zksthcpAUL0Nw_WgEZKBjvYylDJuboL

Millican, J.M. and Agarwal, S., 2021. Plastic pollution: a material problem?. *Macromolecules*, 54(10), pp.4455-4469.
Available at:
https://pubs.acs.org/doi/pdf/10.1021/acs.macromol.0c02814?casa_token=_V0j3GtRT_kAAA%20AA:SwL5Sq4xgxE_9Tl_8G9iQwz19ujdLL5H3XWZbnWlyOsZVDtMJVc01t1rDVpOASVZ%20pMClr-qWLaJiKhI

Orellana, M.A. (2022) Opening remarks, United Nations Special Rapporteur on Toxics and Human Rights, Marcos A. Orellana, at the 76th session of the UN General Assembly | Ohchr.
Available at:
https://www.ohchr.org/en/statements/2022/05/opening-remarks-united-nations-special-rapporteur-toxics-and-human-rights-marcos
(Accessed: 22 May 2024).

Padha, S., Kumar, R., Dhar, A. and Sharma, P., 2022. Microplastic pollution in mountain terrains and foothills: A review on source, extraction, and distribution of microplastics in remote areas. *Environmental Research*, 207, p.112232.
Available at: https://www.sciencedirect.com/science/article/pii/S0013935121015334

Parvez, M.S., Ullah, H., Faruk, O., Simon, E. and Czédli, H., 2024. Role of Microplastics in Global Warming and Climate Change: A Review. *Water, Air, & Soil Pollution,* 235(3), p.201.
Available at: https://link.springer.com/article/10.1007/s11270-024-07003-w

Rangel-Buitrago, N., Neal, W. and Williams, A., 2022. The Plasticene: time and rocks. *Marine Pollution Bulletin*, 185, p.114358.
Available at:
https://www.sciencedirect.com/science/article/pii/S0025326X22010402?casa_token=XQZA9%208OdhjQAAAAA:dGBDTo0Qd_tM0Oj22-pDZzH-Yr5om1TpWq8flXp-C3GKA-7JGHnBPW%206E-lsBwRfYcwrdPlzx7Q

Ragusa, A., Svelato, A., Santacroce, C., Catalano, P., Notarstefano, V., Carnevali, O., Papa, F., Rongioletti, M.C.A., Baiocco, F., Draghi, S. and D'Amore, E., 2021. Plasticenta: First evidence of microplastics in human placenta. *Environment international,* 146, p.106274.
Available at: https://pubmed.ncbi.nlm.nih.gov/33395930/

UN General Assembly, Convention on the Elimination of All Forms of Discrimination Against Women, 18 December 1979, United Nations, Treaty Series, vol. 1249, p. 13
Available at:
https://www.ohchr.org/sites/default/files/Documents/ProfessionalInterest/cedaw.pdf

UN General Assembly, International Covenant on Economic, Social and Cultural Rights, 16 December 1966, United Nations, Treaty Series, vol. 993, p. 3
Available at: https://www.ohchr.org/sites/default/files/cescr.pdf

UN General Assembly, Universal Declaration of Human Rights, 10 December 1948, 217 A (III)
Available
at:https://www.ohchr.org/sites/default/files/UDHR/Documents/UDHR_Translations/eng.pdf

UN, United Nations, UN treaties, treaties (UNTC) United Nations.
Available at: https://treaties.un.org/pages/Index.aspx
(Accessed: 22 May 2024).

World Health Organization. Public Health and Environment (no date) (Accessed: 20 May 2024).
Available at: https://www.who.int/data/gho/data/themes/public-health-and-environment

Yang, W., Jannatun, N., Zeng, Y., Liu, T., Zhang, G., Chen, C. and Li, Y., 2022. Impacts of microplastics on immunity. *Frontiers in Toxicology*, 4, p.956885.
Available at:
https://www.frontiersin.org/articles/10.3389/ftox.2022.956885/full

Yee, M.S.L., Hii, L.W., Looi, C.K., Lim, W.M., Wong, S.F., Kok, Y.Y., Tan, B.K., Wong, C.Y. and Leong, C.O., 2021. Impact of microplastics and nanoplastics on human health. *Nanomaterials*, 11(2), p.496.
Available at : https://www.mdpi.com/2079-4991/11/2/496/pdf

Zhang, C., Chen, J., Ma, S., Sun, Z. and Wang, Z., 2022. Microplastics may be a significant cause of male infertility. *American Journal of Men's Health,* 16(3), p.15579883221096549.
Available at:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9134445/

Zhao, Q., Zhu, L., Weng, J., Jin, Z., Cao, Y., Jiang, H. and Zhang, Z., 2023. Detection and characterization of microplastics in the human testis and semen. S*cience of The Total Environment,* 877, p.162713
Available at:https://doi.org/10.1016/j.scitotenv.2023.162713