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The Potential Presence of Microplastics in Daily Food and Beverage Consumption May Lead to Alzheimer's disease in the Thai Population

Jirattha Jirathitiwong[1], Sasirunchana Askarawatcharangkoon[2], Chanapa Thawonrattanawanit[3]
[1,3]Learn Satit Pattana School (LSP), Bangkok, Thailand
[2]Mater Dei School (MD), Bangkok, Thailand

ABSTRACT: Environmental issues have become a global crisis. The amount of plastic used has relentlessly increased due to its advantages such as low cost production, lightweight, strength and durability. However, high usage of plastic contributes to microplastics, which are small particles that are difficult to detect and may be found in daily food and beverage consumption. Consequently, it is prone to accumulate in our body and affect our organs, including the brain. From recent studies, there are some possibilities that microplastics exposure can promote human brain damage, including Alzheimer's. Due to microplastic concerns, this study aims to find out the relation between microplastics in daily food and beverage consumption and Alzheimer's disease in the Thai population by collecting the responses (509 participants) through a questionnaire. The questionnaire uses Likert scales to evaluate the quantities of daily microplastics consumption, packaging, and Alzheimer assessment. As a result, the data revealed that microplastics consumption has a link to the risk of developing Alzheimer's disease. We show that microplastics consumption and plastic containers are positively correlated for the Thai population. Consequently, in the course of time, it can lead to other causes of Alzheimer's disease diagnosed when microplastics are accumulated in the human body. Moreover, it can raise social awareness through campaigns or policies on plastics used which have to be immediately reduced.

KEYWORDS: Alzheimer's disease, Food consumption, Microplastic, Plastic packaging.

INTRODUCTION

The accumulation of microplastics in the environment and their infiltration into food products present a pressing global concern, posing substantial threats to both environmental sustainability and human health. The widespread utilization of various plastic materials, including food containers, packaging, bottles, disposable cups, infant feeders, plastic-coated materials, and paper cartons, has significantly exacerbated this issue. These plastics facilitate direct contact with food items, leading to the release of microplastic particles, thereby intensifying contamination levels (Jadhav et al., 2021). Additionally, investigations into microplastic contamination in food products in Thailand, such as shellfish sourced from Thai seafood markets, underscore the widespread presence of microplastics in edible items. Analysis revealed varying levels of microplastic abundance in shellfish samples, with fibers being the predominant shape observed in black-gray and transparent colors. This finding emphasizes the potential risks posed to human food safety due to microplastic contamination in seafood (Hongsawat et al., 2024). Moreover, emerging studies suggest a potential link between microplastic exposure and the acceleration of neurodegenerative diseases such as Alzheimer's, primarily through the induction of brain inflammation. Research experiments conducted on mice have demonstrated that microplastics can infiltrate brain tissue and induce memory impairments, highlighting the neurological impacts of microplastic exposure (Eom et al., 2024). Although these microplastics did not elicit changes in locomotion or social behavior, they notably caused memory abnormalities associated with mouse brain diseases (Eom et al., 2024).

Alzheimer's disease represents a form of dementia characterized by impairment in memory, cognitive functions, and behavioral patterns. Over time, the symptoms progress to a degree where they impede the individual's ability to carry out routine activities (WDW Know, 1996). Alzheimer's disease is characterized by severe cytoskeletal alterations in specific neuronal types, manifesting as neurofibrillary tangles and neuropil threads primarily in the allocortex. This degenerative process progresses predictably, engulfing other cortical territories and subcortical nuclei. Clinical symptoms emerge late, coinciding with the involvement of neocortical association areas. The sequence of destruction parallels the inverse of cortical myelination, with late-myelinating areas affected earlier and more intensely. Neuronal pigmentation density correlates with the density of cytoskeletal lesions, particularly in long, thin axons with sparse myelination (Braak et al., 1999). Caregivers of Alzheimer's disease patients exhibit elevated rates of

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mental health disorders, particularly depression and anxiety, compared to both the general populace and caregivers tending to patients with other ailments. Notably, this heightened prevalence is predominantly observed among female caregivers, those caring for male recipients, and individuals in spousal relationships with care recipients (Sallim et al., 2015). While anxiety prevalence is also notably increased in this cohort, further investigation is warranted to elucidate this relationship comprehensively. Dr. Phusanu Thanapornsangsuthit, a lecturer in neurology, stated that there are approximately 50 million individuals worldwide experiencing symptoms of dementia currently (Panlee, 2022). Specifically, in Thailand, there are an estimated 700,000 individuals with dementia. Within this figure, 500,000 are attributed to Alzheimer's disease. Without intervention measures at both individual and societal levels to delay or prevent the onset of dementia, the number of patients is projected to increase. It is anticipated that globally, the elderly population suffering from dementia will triple within the next thirty years (Panlee, 2022).

In response to the emerging concern regarding the discovery of microplastics in food and packaging contamination in Thailand, potentially associated with an increased risk of Alzheimer's disease, this research endeavors to fill a critical gap in the existing literature. To date, no comprehensive study has been conducted in Thailand to investigate the correlation between microplastic contamination in food consumption and the incidence of Alzheimer's disease. Therefore, the primary objective of this study is to address this knowledge gap by examining the relationship between dietary habits, particularly the consumption of microplastic-contaminated food, and the risk of Alzheimer's disease among a sample group in Thailand. Furthermore, this study aims to contribute to various aspects of public health and policy. Firstly, it seeks to raise awareness among the public regarding the potential health implications of microplastic contamination in food. Secondly, by elucidating the link between microplastics and Alzheimer's disease, the research aims to encourage individuals to adopt healthier dietary habits and lifestyle choices. Additionally, the findings of this study have the potential to inform policymakers and regulatory authorities in Thailand, facilitating the formulation and enforcement of regulations aimed at mitigating microplastic contamination in food products. Ultimately, it is anticipated that the outcomes of this research will contribute to reducing the incidence rate of Alzheimer's disease in Thailand and promoting the overall well-being of the population.

METHOD

The survey research was conducted to reveal the correlation between microplastics in daily food and beverage consumption and Alzheimer's disease in the Thai population. The questionnaires consist of 3 parts, which were divided into 4 sections namely: 1) General information, 2) Microplastics in food and beverage consumption, 3) Microplastics in food and beverage packaging, and 4) Alzheimer assessment. The responses were collected mainly using a 5-point Likert scale, with ratings from 1 to 5, including never, rarely, sometimes, usually, and always, respectively. Furthermore, due to the sampling procedure, the survey used a convenience sampling method to affirm the correlation. Each question was revised by three specialists and obtained the Item-Objective Congruence (IOC) index scores higher than or equal to 0.5. Moreover, Cronbach's alpha was used for determining the reliability of questionnaires, where we obtained an acceptable value of 0.757, which refers to high internal consistency (Bujang et al., 2018). In terms of conductions, the survey was launched by Google Forms via Line and Instagram applications during April-May 2024. We obtained a total of 509 participants. Ultimately, in this study, we used Statistical Package for the Social Sciences (SPSS) version 29.0.2.0 (20) to perform the data. Pearson (r-value) was used to find the correlation between variables, a t-test was used to find the differences between the 2 groups, and an F-test (ANOVA) was used to find the differences between over 2 groups.

INSTRUMENTS

General information

1. Please select your gender
2. Please select the age group you are in
3. Do you smoke?
4. Do you have a neurological and brain underlying medical condition?

Microplastics in food and beverage consumption

1. How often do you eat salty foods especially bread, sausage, snack, and whey protein
2. How often do you eat seafood, such as clams, fish, and shrimps
3. The head of the fish is the part you usually like to eat.

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4. How often do you drink beer
5. How often do you drink milk
6. How often do you eat or drink honey
7. How often do you eat food including sugar
8. How often do you eat seaweed or dried fish
9. How often do you eat apples
10. How often do you eat carrots

Microplastics in food and beverage packaging

1. How often do you drink water in plastic bottles or cans?
2. How often do you have take-away meals?
3. How often do you drink tea in the teabags?
4. How often do you have processed food?
5. How often do you have a meal or beverage in plastic packages?

Alzheimer assessment

1. You often forget what day of week it is.
2. When you are looking for something, you often forget what you are looking for
3. Friends and family always say you are more forgetful than you used to be.
4. Sometimes, you experience difficulty naming people or things.
5. You appear to find it challenging to add two-digit numbers mentally.
6. Friends and family have said that you frequently ask the same questions, saying the same sentence or the same story many times in one day.
7. You frequently miss appointments because you forget them.
8. You are not very alert during the day.
9. You have trouble concentrating on one thing for more than one hour.
10. You have trouble concentrating on one thing for more than one hour.
11. You frequently forget your topics when you have a conversation.
12. Sometimes you get lost in a familiar place. You frequently spend a lot of time digesting the lessons.
13. You frequently spend a lot of time digesting the lessons.
14. Sometimes you use tools or devices that are more difficult to use every day, such as mobile phones, and remote.

RESULTS

Table 1. General information

	Frequency	Valid Percent
Gender		
Female	386	75.8
Male	120	23.6
Others	3	0.6
Age		
Below 21 years	176	34.6
21-40 years	39	7.7
41-60 years	251	49.3

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Above 60 years	43	8.4
Do you smoke?		
Yes	13	2.6
No	496	97.4
Do you have a neurological and b rain underlying medical condition?		
Yes	13	2.6
No	496	97.4

Table 1 illustrates the general information of 509 participants. The majority of samples was female with the figures being 386 (75.8%). Most of the responses are in the age range between 41-60 years old with 251 (49.3%). In addition, there are 496 people (97.4%) who do not smoke, which is a greater number when compared to 13 people (2.6%) who smoke. Out of 509 responses, there are 13 people (2.6%) with neurological and brain underlying medical conditions.

Table 2: Descriptive statistics (Mean, Standard Deviation)

	N	Mean	Std.Deviation
Microplastics in Food and Beverage Consumption	509	2.63	0.48
Microplastics in Food and Beverage Packaging	509	3.35	0.79
Alzheimer Assessment	509	2.07	0.63

According to Table 2, the minimum score is 1 and the maximum score is 5, of which 5 is the highest frequency of receiving microplastics and the chance of developing Alzheimer's disease. Moreover, the table presents each mean score and standard deviation of consumption, packaging, and Alzheimer's assessment. It is clear that the mean scores are 2.63, 3.35, and 2.07, respectively. While the standard deviations are 0.48, 0.79, and 0.63, respectively.

Table 3: One-way ANOVA (F-test); Age and Alzheimer's disease

	SS	df	MS	F	P-value
Between Groups	23.21	3	7.74	21.48**	<0.001
Within Groups	181.89	505	0.36		
Total	205.11	508			

According to Table 3, the one-way ANOVA results obtained a p-value <0.001. In other words, the risk of developing Alzheimer's disease is significantly different between age groups, due to the fact that p-value is less than 0.01.

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Table 4: One-way ANOVA (F-test); Age and Consumption

	SS	df	MS	F	P-value
Between Groups	14.35	3	4.78	23.74**	<0.001
Within Groups	101.76	505	0.20		
Total	116.11	508			

According to Table 4, the one-way ANOVA results obtained a p-value <0.001. In other words, there are significant effects of age on consumption behavior, due to the fact that p-value is less than 0.01.

Table 5: One-way ANOVA (F-test); Gender and Alzheimer's disease

	SS	df	MS	F	P-value
Between Groups	2.53	2	1.27	3.16*	0.043
Within Groups	202.58	506	0.40		
Total	205.11	508			

According to Table 5, the one-way ANOVA results obtained a p-value of 0.043. In other words, the risk of developing Alzheimer's disease is significantly different between genders, due to the fact that p-value is less than 0.05.

Table 6: Pearson's Correlation between consumption and Alzheimer's disease

		Consumption	Alzheimer's
Consumption	Pearson Correlation	1	0.369**
	Sig. (2-tailed)		<0.001
	N	509	509

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

According to Table 6, the results between microplastic consumption and Alzheimer's disease illustrated that they had a significant correlation (r = 0.369), supporting our assumption that they had a positive correlation.

Table 7: Pearson's Correlation between packaging and Alzheimer's disease

		Packaging	Alzheimer's
Packaging	Pearson Correlation	1	0.241**
	Sig. (2-tailed)		<0.001
	N	509	509

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

According to Table 7, the results between packaging materials and Alzheimer's disease illustrated that they had a significant correlation (r = 0.241), supporting our assumption that they had a positive correlation.

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Table 8: Pearson's Correlation between consumption and packaging

		Consumption	Packaging
Consumption	Pearson Correlation	1	0.466**
	Sig. (2-tailed)		<0.001
	N	509	509

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

According to Table 8, the results between microplastic consumption and packaging materials illustrated that they had a significant correlation (r = 0.466), supporting our assumption that they had a positive correlation.

DISCUSSION

In this contemporary society, Alzheimer's disease is a significant concern in Thailand, especially among individuals aged over 60. This disease may be caused by environmental factors and lifestyle choices but also by "microplastics" in food products and packaging, one potentially overlooked problem. Thus, it is important to understand the correlation between microplastics and Alzheimer's disease.

To investigate this, we conducted a survey through a questionnaire, asking the Thai population to complete the form about their dietary habits and behavior of people with Alzheimer's disease. From Table 1, our participants comprise people in different age ranges, including those 21 years old (34.6%), 21-40 years old (7.7%), 41-60 years old (49.3%), and over 60 (8.4%). From our sampling group, the results show that age had a significant effect on Alzheimer's disease and microplastics consumption as displayed in Tables 3 and 4. The results shown in Table 3 illustrated a significant difference of Alzheimer's risk to different age groups. This illustration is very similar to a research by John C. Morris, who studied about "Is Alzheimer's disease inevitable with age?" and the results of his research showed that Alzheimer's disease may become universal when age is sufficiently advanced (Morris, 1999). So, our results from the survey and the research of John C. Morris is in agreement that age has a significant effect on Alzheimer's disease. Moreover, due to Table 2, the mean score on the rating scale that people rated showed that in the mean score in question about receiving microplastics through consumption, packaging and development of Alzheimer's disease are 2.63, 3.35 and 2.07, respectively. These are more than half of the maximum score of receiving microplastics and developing Alzheimer's disease which the minimum score is 1 and the maximum score is 5.

According to Table 5, gender had a significant effect on Alzheimer's disease as well. This is similar to a study done in the US about "Mechanisms of sex differences in Alzheimer's disease," reported by Chloe Lopez-Lee, Eileen Ruth S. Torres, Gillian Carling, and Li Gan. They obtained the results that microglia have become apparent as a common denominator in Alzheimer's disease risk. To illustrate, the role of microglia in Alzheimer's disease and potentially Alzheimer's sex bias in risk toward women (Lopez-Lee et al., 2024). Even though there are many gaps in current knowledge, and there are many other important mechanisms needed to be understood. Our results are likely to be influenced by a higher proportion of females (75.8%) than males (23.6%) (Table 1).

Additionally, from Table 6 and 7, they indicated that microplastics consumption and packaging materials had a positive correlation with Alzheimer's disease, with r-value of 0.369 and 0.241, respectively. This is in agreement with the research from the University of Rhode Island done by Lauren Gasper, Sydney Bertman, Giuseppe Coppotelli, and James M. Ross. They reported that mice, especially an older one, had a tendency to increase in anxiety and a decrease in mental acuity after consuming water containing microplastics (Gaspar et al., 2023). This mouse's behavior is similar to dementia in humans, supporting our hypothesis about the positive correlation between the two of them. Lastly, in Table 8, the results obtained showed that microplastics consumption positively correlates with packaging materials (r = 0.466), which means that people who have a high rate of consuming food containing microplastics are having a high rate of using microplastics packaging as well.

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CONCLUSION

In summary, our finding indicates a positive correlation between microplastic consumption and the risk of developing Alzheimer's disease. We show a link between people who consume a lot of microplastics through both food and beverages via various sources, such as seafood, dairy, beer, honey, sugar, apples, and carrots, tend to have a high rate of developing Alzheimer's disease. Furthermore, individuals who frequently utilize packaging materials infused with microplastics, including plastic bottles and teabags, exhibit a propensity toward developing Alzheimer's disease. Lastly, there is a significant correlation between microplastics consumption and the use of microplastic packaging. In other words, people who eat a lot of food containing microplastics also often use microplastic packaging. Therefore, our results support the hypothesis that there is a positive correlation among these three variables. However, in our research, there is an obvious bias among the participant genders. Therefore, in future research, we will collect data in a more equitable proportion to reduce an inaccurate gap between genders.

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