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Exploring the Commercial Availability and Marketing Claims of Cognitive-Enhancing Dietary Supplements: A Comparative Analysis of Offline and Online Retail Platforms

(Penerokaan Suplemen Komersial Dan Tuntutan Pemasaran Suplemen Peningkatan Kognitif: Analisis Perbandingan Luar Talian Dan Dalam Talian)

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Abstract

Public interest in cognitive enhancement has driven the widespread availability of dietary supplements claiming to support brain health and memory. This comparative cross-sectional study explores the commercial availability and marketing claims of cognitive-enhancing dietary supplements across offline and online retail platforms. A dual-component design was employed in a comparative cross-sectional study. The first component involved assessing the commercial availability and marketing claims of cognitive-enhancing dietary supplements sold through offline retail outlets in Kuala Lumpur using a purposive sampling approach. The second component consisted of a parallel assessment conducted on online platforms, employing a convenience sampling strategy. A total of 13 products were identified on offline retail platforms in Kuala Lumpur, and 117 products were identified on online platforms. Capsules were the most common dosage form, both offline (46.2%) and online (79.5%). Products sold offline most frequently originated from Singapore (69.2%), whereas online products predominantly came from the United States of America (74.4%). The median prices of offline products were RM 190 (55.5), and online products were RM 196 (183), which are comparable, although the online products exhibited a wider price range (RM14–RM1,147). The most frequent claims were "brain health" for offline products and "memory" for online products. Natural or compound extracts were the most common active ingredients. This study's findings found significant differences between offline and online dietary supplements in terms of availability, country of origin, price and marketing claims. These inconsistent findings underscore the need for stronger regulation and improved transparency in labelling to safeguard consumer health and ensure product credibility. Future research should focus on dosage accuracy, long-term safety, and mechanisms of action for supplements with cognitive-enhancing claims.

Keywords: Dietary supplements, cognitive impairment, memory, brain, marketing

Abstrak

Minat orang ramai terhadap peningkatan kognitif telah mendorong kepada ketersediaan meluas suplemen pemakanan yang mendakwa mampu menyokong kesihatan otak dan ingatan. Kajian keratan rentas perbandingan ini meneroka suplemen komersial dan tuntutan pemasaran suplemen peningkatan kognitif di platfom luar talian dan dalam talian. Reka bentuk kajian rentas perbandingan yang terdiri daripada dua komponen telah dijalankan. Komponen pertama telah menilai suplemen komersial dan tuntutan pemasaran suplemen peningkatan kognitif yang dijual di premis fizikal yang berada di Kuala Lumpur menggunakan kaedah persampelan bertujuan. Komponen kedua meneroka suplemen peningkatan kognitif yang dijual di platform dalam talian menggunakan kaedah persampelan mudah. Sebanyak 13 suplemen telah dikenal pasti daripada kedai fizikal di Kuala Lumpur dan 117 suplemen daripada platform dalam talian. Kapsul merupakan bentuk dos yang paling lazim, sama ada di luar talian (46.2%) mahupun dalam talian (79.5%). Produk yang dijual di luar talian kebanyakannya berasal dari Singapura (69.2%), manakala suplemen dalam talian kebanyakannya berasal dari Amerika Syarikat (74.4%). Harga median suplemen luar talian ialah RM190 (55.5) dan suplemen dalam talian RM196 (183), namun harga suplemen dalam talian mempunyai julat harga yang lebih besar (RM14–RM1,147). Tuntutan yang paling kerap ialah "kesihatan otak" bagi produk luar talian dan "memori" bagi produk dalam talian. Ekstrak semula jadi atau ekstrak sebatian merupakan bahan aktif yang paling biasa digunakan. Dapatan kajian ini telah menunjukkan perbezaan yang signifikan antara suplemen luar talian dan dalam talian terutamanya dari segi ketersediaan, negara asal, harga, dan tuntutan pemasaran. Ketidakselarasan dapatan kajian ini menekankan keperluan penguatkuasaan peraturan yang lebih kukuh dan ketelusan dalam pelabelan untuk melindungi kesihatan

pengguna serta memastikan kredibiliti produk. Kajian lanjutan perlu memberi tumpuan kepada ketepatan dos, data keselamatan jangka panjang, dan mekanisme tindakan suplemen dengan tuntutan peningkatan fungsi kognitif.

Kata Kunci: Suplemen diet, kemerosotan kognitif, memori, otak, pemasaran

INTRODUCTION

Cognitive impairment and dementia represent significant public health challenges worldwide, driven by the rapid growth of the ageing population (Iadecola et al. 2019; Lane et al. 2018). Recent data from Malaysia indicates that the overall probable dementia prevalence rate in older adults has been reported at 8.5% (Ministry of Health Malaysia, 2018), which is lower than the prevalence of dementia in Singapore (8.8%). However, the prevalence of dementia decreased from 10% to 8.8% over a decade in Singapore (Subramaniam et al. 2025). In contrast, the prevalence of dementia in Malaysia doubled from 2019 to 2023 (Ministry of Health Malaysia 2023). Additionally, the prevalence of older adults (60 years old and above) is expected to increase to 15.3% by 2030, representing approximately 5.8 million individuals. The proportion of older adults (≥60 years) in Malaysia is projected to rise from 15.3% in 2030 to 8.2 million individuals by 2040 (Abdullah et al. 2024), further intensifying the need for effective strategies to maintain cognitive health.

Global demand for dietary supplements and functional foods that support cognitive health has increased rapidly, driven by interest in enhancing mental performance and reducing the risks of dementia and Alzheimer's disease (Fuentes et al. 2024). Reflecting this trend, the global brain health supplement market was valued at USD 8.63 billion in 2022 and is projected to grow at a compound annual growth rate of 13.3% from 2023 to 2030, with the Asia-Pacific region identified as the fastest-growing market (Grand View Research 2023). However, alongside this growth, concerns have emerged regarding the potential disadvantages and side effects of cognitive enhancers. A wide range of products, including herbal formulations, nootropics, and functional foods, is marketed with claims of enhancing memory, focus, and mental performance, and these are aggressively promoted through online platforms and health-related retail outlets worldwide (Djaoudene et al. 2023; Vanhee et al. 2025). In Malaysia, particularly in urban centres such as Kuala Lumpur, these products are easily accessible through pharmacies, health stores, and e-commerce platforms like Shopee and Lazada (Shafi et al. 2024; Wahab et al. 2023; Xin et al. 2024).

Despite this growth, concerns remain regarding the safety, efficacy, and ethical implications of cognitive enhancers. Previous reviews of pharmacological cognitive enhancers (e.g., modafinil, methylphenidate) have highlighted the unresolved issues surrounding their mainstream use, including uncertainties about long-term safety, fairness, and the blurred boundaries between treatment and enhancement (Choy 2015). More recently, a study emphasized the "dark side" of smart drugs, warning that many are marketed without prescription or adequate risk assessment, and that unregulated use may lead to neurotoxicity, psychological harm, and even cognitive decline (Ingegneri et al. 2025). These findings highlight the urgent need for systematic documentation and evaluation of cognitive-enhancing products available to the public.

Despite their widespread availability, concerns remain regarding the safety, efficacy, and accuracy of claims made by such products. These concerns are amplified by the fact that cognitive enhancement can be pursued through diverse strategies, including biochemical, physical, and behavioural, yet dietary supplements are often promoted as convenient solutions without sufficient scientific validation (Dresler et al. 2019). Therefore, this comparative cross-sectional study explores the commercial availability and marketing claims of cognitive-enhancing dietary supplements across offline and online retail platforms. The findings will provide evidence to guide consumers in making informed choices and may serve as a reference for policymakers in strengthening regulations to prevent misleading product claims.

MATERIALS AND METHODS

Study Design and Location/Platform

This study is an observational cross-sectional study. A quantitative approach was applied to explore and compare the commercial availability and marketing claims of cognitive-enhancing dietary supplements across offline and online retail platforms. This study employed a dual-component design, utilizing a comparative cross-sectional approach. The first component involved assessing the commercial availability and marketing claims of cognitive-enhancing dietary supplements sold through offline retail outlets in Kuala Lumpur using a purposive sampling approach. The second component consisted of a parallel assessment conducted on online platforms, employing a convenience sampling strategy.

The quantitative method was employed to gather packaging information on various dietary supplements with cognitive-enhancing claims in Kuala Lumpur and on online platforms. For the first component, which was offline, data collection was conducted at supermarkets, pharmacies, and wellness retailers in Kuala Lumpur. The reason for choosing Kuala Lumpur as a study location was that it is the capital city of Malaysia and has numerous major supermarkets, pharmacies, and wellness retailers. Kuala Lumpur was more easily accessible to the researcher near the UKM KL campus. This helps reduce time and cost during the data collection period. Supermarkets included Aeon, Giant, Village Grocer, Jaya Grocer, Mydin, and Econsave. Pharmacy stores included Big Pharmacy, Caring Pharmacy, and Healthlane Pharmacy. Wellness retailers such as LAC, Guardian, and Watsons were included to capture health-related supplements. These supermarkets, pharmacies, and wellness retailers were selected because they are major retail chains in Malaysia offering a wide range of products. For the online component of this study, data collection was conducted on e-commerce platforms such as Shopee, Lazada, and Amazon, with priority given to the most used e-commerce platform by Malaysian consumers. This comparative cross-sectional study didn't include direct-selling supplements brands such as Nutrilite (Amway), USANA, Excelife, Himalaya, or Herbalife, as those products were not found through offline retail stores during the data collection process and therefore did not meet the inclusion criteria for data collection.

Sample selection

The sampling method used in this study is purposive sampling. Purposive sampling was employed to select offline retailers, while convenience sampling was used for online platforms commonly used by Malaysian consumers. Dietary supplements were selected based on meeting the inclusion criteria, which included products either approved or unapproved by the Ministry of Health Malaysia, as well as those with cognitive-enhancing claims. Meanwhile, dietary supplements without specific cognitive-enhancing claims, such as those that only promote general health, and products with incomplete or unclear information were excluded.

The inclusion of dietary supplements with cognitive-enhancing claims, with or without Ministry of Health Malaysia approval, was based on the presence or absence of the NPRA registration number and the hologram on the dietary supplements. The dietary supplements with registration numbers and holograms were classified as approved, while those without registration numbers and holograms were classified as unapproved. Additionally, the cognitive-enhancing claims were defined as any claims on the packaging of dietary supplements that claim to improve, help, support, or maintain cognitive functions, such as memory, focus, brain health, learning ability, or mental well-being. This comparative cross-sectional study included dietary supplements with cognitive-enhancing claims, while those without specific cognitive-enhancing claims were excluded.

Data collection parameters

The primary source of this study was the collection of data, which took place over a period of two and a half months. The data collection was conducted in accordance with data parameters developed based on the specific dossier requirements for the registration of health supplements set by the NPRA (National Pharmaceutical Regulatory Agency 2023), and included additional parameters, such as price and dosage instructions for research purposes. The data collection parameters being collected from the packing information of dietary supplements that have cognitive-enhancing claims included the name of the products, brand, dosage forms (capsules, tablets, and more), country of origin (Malaysia and more), cognitive-enhancing claims (brain health, memory, and more), active ingredients, price, and dosage instructions. The data included a diverse range of dietary supplements.

Statistical analysis

The SPSS Statistics application version 26 (IBM Corp., Armonk, New York) was used for descriptive analysis. Numerical variables were analyzed for normality by using skewness and kurtosis. The primary objective of this comparative cross-sectional study was to investigate the commercial availability and marketing claims of cognitive-enhancing dietary supplements across offline and online retail platforms, with two specific objectives. The first specific objective was to determine the packaging information of different dietary supplements with cognitive-enhancing claims in Kuala Lumpur and on online platforms. Descriptive statistics were applied, including frequency, median, Interquartile range (IQR), minimum, and maximum values. The second specific objective was to document the active ingredients and cognitive-enhancing claims of the products in Kuala Lumpur and on online platforms. An analysis was conducted using a summary table that includes the active ingredients and relevant cognitive-enhancing claims to summarize the most common key ingredients used and the most frequently cited cognitive-enhancing claims.

RESULTS

Product information

Table 3.1 shows that the dietary supplements collected through the offline mode were 13, and the online dietary supplements with cognitive-enhancing claims were 117. Furthermore, most of the cognitive-enhancing claims dietary supplements were available in capsule form (46.2% offline, 79.5% online), followed by tablets (38.5% offline, 17.1% online). Powder/granules (0% offline, 0.9% online), liquid (0% offline and online), and others (15.4% offline, 2.6% online) were scarce in cognitive-enhancing claims dietary supplements. Besides, the origin country of dietary supplements with cognitive-enhancing claims in the offline mode was mainly Singapore (69.2%), followed by Malaysia (23.1%), and then India, with only one product. In online cognitive-enhancing claims, the origin countries of dietary supplements were more diverse and completely different from those of offline dietary supplements. The largest was from the United States of America (USA) (74.4%), followed by Singapore (8.5%) and Malaysia (3.4%). Additionally, dietary supplements with cognitive-enhancing claims from China accounted for 3.4%, whereas in the UK, they represented only 2.6%. The dietary supplements from Australia and Canada were the same, at only 1.7%. The rest of the countries, such as Sweden, South Korea, Switzerland, Japan, and India, had a similar rate, which was only 0.9%.

Table 3.1 Product information

Variables (Quantity)	**N (%)**	
Mode	**Offline (n=13)**	**Online (n=117)**
Dosage forms		
Capsules (1)	6 (46.2)	93 (79.5)
Tablets (2)	5 (38.5)	20 (17.1)
Powder/granules (3)	0 (0)	1 (0.9)
Liquid (4)	0 (0)	0 (0)
Others (5)	2 (15.4)	3 (2.6)
Country Origin		
Malaysia (1)	3 (23.1)	4 (3.4)
Singapore (2)	9 (69.2)	10 (8.5)
UK (3)	0 (0)	3 (2.6)
USA (4)	0 (0)	87 (74.4)
Australia (5)	0 (0)	2 (1.7)
China (6)	0 (0)	4 (3.4)
Sweden (7)	0 (0)	1 (0.9)
Canada (8)	0 (0)	2 (1.7)
South Korea (9)	0 (0)	1 (0.9)
Switzerland (10)	0 (0)	1 (0.9)
Japan (11)	0 (0)	1 (0.9)
India (12)	1 (7.7)	1 (0.9)

Price and dosage information

The study also analyzes the price range of cognitive-enhancing dietary supplements on both offline and online platforms (Table 3.2). The key finding was that the mean price of offline cognitive-enhancing dietary supplements was RM 225.40, with a price range from RM 60.00 to RM 655.00. Meanwhile, the mean price of online cognitive-enhancing dietary supplements was RM229.30, with a price range of RM14.00 to RM1,147.00. Additionally, the mean dosage for offline was 1.5, while for online it was 2.0.

Table 3.2 Price information

Variables	Offline	Online
Price/bottle (RM)		
Mean ± SD	225.4 ± 156.8	229.3 ± 167.7
Min	60.0	14.0
Max	655.0	1147.0
Price/day (RM)		
Mean ± SD	6.6 ± 5.8	6.9 ± 5.6
Min	1.0	0.3
Max	22.0	38.0
Dosage/day		
Mean ± SD	1.5 ± 0.8	2.0 ± 0.9
Min	1	1
Max	3	6

Active Ingredients

Table 3.3 shows that the active ingredients were grouped into categories, including natural extracts or compound extracts, vitamins, minerals, amino acids or derived nutrients, fatty acids, and others. There were 57 types of active ingredients in the natural extract or compound extract category (51.8%). Additionally, the vitamins category comprised 12 types (10.9%), while the minerals category consisted of 13 types (11.8%). The amino acid or derived nutrient category had 16 types of active ingredients (14.5%), while the fatty acid category had 7 (6.3%). The other category consisted of only five types of active ingredients (4.5%), which included Maltitol (a sweetener), Inositol (a sugar alcohol), Lithium Ascorbate, Vinpocetine (a man-made chemical), and Inulin (a prebiotic).

Table 3.3 Active ingredients category

Category	Number of Active Ingredients (%)	Active ingredients		
Natural extract/ compound	57 (51.8)	*Bacopa Monnieri*	Red Clover	
		Pomegranate	Kelp	Galangal
		Chaga Mushroom	Hyssop Leaf	*Ginkgo Biloba*
		Cordyceps	Chervil	Wheat
		Shiitake Mushroom	Bayberry Bark	Sage
		Turkey Tail	Blueberry	Holy Basil
		Maitake Mushroom	Green Tea	Pine Bark
		Cinnamon	Curcumin	Lion's Mane
		Grape Seed	*Ashwagandha*	Coffee Fruit
		Grape	*Centella Asiatica*	Propolis
		Liquorice Root	*Gotu Kola*	Huperzine A
		Apple	*Morinda Officinalis*	Spermidine
		Tongkat Ali	Chinese Dodder	Apigenin
		Horny Goat Weed	Ginseng	Cocoapro *(Compound Extract)*
		Wild Yam	Rhodiola	
		Bitter Melon	Polygonatum	Scallop-derived
		Butterfly Pea	Polygala	Plasmalogen *(Compound Extract)*
		Chamomile	Bilberry	
		Fenugreek	*Danshen*	Smartseed *(Compound Extract)*
		Dandelion	*Lingzhi*	
		Blessed Thistle	*Reishi*	
Vitamins	12 (10.9)	Vitamin A	Vitamin B5 (Pantothenic Acid)	Vitamin B12 (Cobalamin)
		Vitamin B1 (Thiamine)	Vitamin B6 (Pyridoxine)	Vitamin C
		Vitamin B2 (Riboflavin)	Vitamin B7 (Biotin)	Vitamin D
		Vitamin B3 (Niacin)	Vitamin B9 (Folate)	Vitamin E

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Minerals	13 (11.8)	Iodine Boron Vanadium Potassium Molybdenum	Chromium Manganese Copper Selenium	Calcium Iron Zinc Magnesium
Amino acids/ nutrients derived	16 (14.5)	Silk Fibroin Peptide Uridine-5-Monophosphate Citicoline Phosphatidylserine Glutamic Acid Creatine Dimethylethanolamine (DMAE)	L-alpha-glyceryl phosphorylcholine (Alpha-GPC) Gamma-aminobutyric acid (GABA) Taurine DL-Phenylalanine	N-Acetyl-L-Tyrosine (NALT) N-Acetyl-L-Cysteine (NAC) Acetyl-L-Carnitine (ALCAR) L-Tryptophan L-Theanine
Fatty Acids	7 (6.3)	Oleic Acid (OA) Linoleic Acid (LA) Omega-3 Fish Oil	Gamma-Linolenic Acid (GLA) Eicosapentaenoic acid (EPA)	Docosahexaenoic acid (DHA) Alpha Lipoic Acid (ALA)
Others	5 (4.5)	Maltitol (sweetener) Inositol (sugar alcohol)	Lithium Ascorbate Inulin (prebiotic)	Vinpocetine (man-made chemical)

Cognitive-enhancing claim

Based on Table 3.4, the most frequent cognitive-enhancing claims on online platforms were related to memory (54.7%), followed by cognitive enhancement (40.2%), focus (40.2%), and brain health (36.8%). Moreover, offline products had a narrow range of claims, with the most frequent claims being brain health (53.8%), followed by cognitive (38.5%) and focus (30.8%). The claims, such as mood, learning, and anti-ageing or neuroprotection, were 0%, which were not found in any offline products.

Table 3.4 Cognitive-enhancing claims

Variables	**N (%)**	
Mode	Offline (n=13)	Online (n=117)
Cognitive-enhancing claims		
Memory (short-term & long-term)	3 (23.1)	64 (54.7)
Cognitive (function & performance & decline)	5 (38.5)	47 (40.2)
Mental (clarity & precision & performance)	1 (7.7)	33 (28.2)
Focus (concentration & alertness)	4 (30.8)	47 (40.2)
Brain (health & function)	7 (53.8)	43 (36.8)
Mood (emotional)	0 (0.0)	12 (10.3)
Learning (Intelligence & IQ)	0 (0.0)	3 (2.6)
Anti-Ageing and Neuroprotection	0 (0.0)	14 (12.0)
Others	2 (15.4)	30 (25.6)

DISCUSSION

The number of dietary supplements with cognitive-enhancing claims differed significantly between offline and online platforms because dietary supplements were under the control of the National Pharmaceutical Regulatory Agency in Malaysia, and supplements could not simply claim cognitive-enhancing benefits (National Pharmaceutical Regulatory Agency 2023). Moreover, dietary supplements sold offline in Malaysia must be approved by the Ministry of Health's hologram, which is under the control of the NPRA (National Pharmaceutical Regulatory Agency). The dietary supplements with cognitive-enhancing claims available online were numerous and complex for regulatory bodies to regulate due to the variety of products (Ang, Ooi, Abd.Aziz, et al. 2023). Moreover, online marketing was found to be more effective for these cognitive-enhancing claims of dietary supplements, which may mislead consumers who intend to make online purchases, especially after the COVID-19 pandemic (Djaoudene et al. 2023). Thus, a greater number of dietary supplements were found online. Moreover, online marketing was found to be stronger for these cognitive-enhancing claims of dietary supplements, which may mislead consumers intending to make online purchases, especially after the COVID-19 pandemic

Furthermore, most dietary supplements with cognitive-enhancing claims were available in capsule form, followed by tablets, while powders, granules, liquids, and other forms were scarce among dietary supplements with cognitive-enhancing claims. This aligns with the National Pharmaceutical Regulatory Agency (NPRA) guidelines, which permit tablets, capsules, powders, and liquids in Malaysia (National Pharmaceutical Regulatory Agency). The prevalence of capsule forms of dietary supplements is higher, which may be due to their ease of consumption and larger doses. The findings indicate that in recent years, tablet dosage forms, oral routes of administration, and once-daily intake have been the most preferred options (Limenh et al. 2024; Milián-Guimerá et al. 2023). However, capsules are the safest and most acceptable form of oral administration for patients, especially if the drug has a bad taste, odour, or is photosensitive (Kaur et al. 2019; Patel 2024).

The analysis revealed that offline markets were primarily dominated by products from neighbouring countries, particularly Singapore and Malaysia, whereas online platforms were saturated with supplements originating from the United States and a broader range of other countries. This contrast suggests that local regulatory frameworks and distribution networks restrict the offline supply to a narrower range of origins, while online markets provide consumers with easier access to international brands. The predominance of U.S. products online may reflect the country's strong nutraceutical industry, aggressive digital marketing, and global consumer trust in American brands. At the same time, Malaysian consumers tend to associate imported products with higher quality and efficacy, a perception reinforced by branding and globalization trends (Ang, Ooi, Abd Aziz, et al. 2023; Naalchi Kashi 2013; Nhat Vuong & Giao 2019). The USA dominated online sales because it had the highest dietary supplement market sales revenue in the world (47.79 billion) (Cognitive Market Research 2025), and the USA's leading position is also driven by strong regulatory frameworks, specifically the Dietary Supplement Health and Education Act (DSHEA) of 1994, which fosters consumer trust (Bose & Sharma 2025). Moreover, USA brands leverage aggressive digital marketing strategies and e-commerce platforms like Amazon to penetrate international markets, including Malaysia (Companies Market Cap 2025). However, the reliance on imported supplements also raises issues related to safety, authenticity, and regulatory oversight, as many of these products bypass local approval processes. This highlights the need for stronger monitoring of cross-border e-commerce and increased consumer education on evaluating the credibility of supplements.

The online price range was wider than the in-store price range. This may be due to the higher costs, such as rental of shop lots, overhead costs (Zielke & Komor 2025) and online sales, which alleviate inventory pressure, resulting in low operating costs, and an operating scale that is not limited by the site (Wang 2023). A recent study found that online shopping is now more preferred by people due to its convenience, which allows them to shop anytime, anywhere, and offers a wider selection, making it easier to access a large number of merchandise (Priyadharshini 2025). Additionally, it offers better prices, including discounts and special offers. This also aligns with the behaviour of Millennials and Gen Z, who are more likely to continue buying online due to the wide selection of products available, competitive prices that are friendly to one's budget, and the convenience of shopping online (Larano et al. 2023).

The analysis of active ingredients in cognitive-enhancing dietary supplements marketed in Kuala Lumpur and selected online platforms reveals that natural extract or compound extracts were the most predominant category. This was also the case with global market trends, where herbs and botanicals, such as Gingko biloba, American ginseng, and *Bacopa monnieri*, currently dominate the nootropic marketplace due to the consumer mindset of "natural," safety, and efficacy in brain health (Malík & Tlustoš 2022; Roe & Venkataraman 2021). Besides, amino acids and nutrients derived compounds, such as L-theanine (Hidese et al. 2019), citicoline (Gareri et al. 2015), and phosphatidylserine (Ma et al. 2022), are often claimed to be cognitive-enhancing dietary supplements due to their roles in neurotransmitter synthesis, membrane integrity, and synaptic plasticity. The cognitive-enhancing dietary supplement manufacturer often includes these amino acids and nutrient-derived compounds to target products towards cognitive enhancement and neuroprotection. Vitamins and minerals are involved in energy production, metabolism, DNA synthesis, oxygen transport, and neuronal function (Kennedy 2016; Tardy et al. 2020). Thus, these roles are crucial for brain and muscle function, and they have an impact on cognitive and psychological processes. Additionally, some studies suggest that minerals such as magnesium, iron, copper, zinc, selenium and manganese may be involved in brain mechanisms related to cognitive functions, including roles in DNA repair, the prevention of oxidative damage, and facilitating methylation processes (Lorenzo-Mora et al. 2023). Omega-3 polyunsaturated fatty acids (PUFAs), such as DHA and EPA, with DHA being the most important omega-3 PUFA in the brain, play indispensable roles in the neuronal membrane. EPA and DHA have independent effects on their respective anti-inflammatory mediators (Dyall 2015).

The most frequent cognitive-enhancing claims on online platforms were related to memory, followed by cognitive enhancement, focus and brain health. These claims align with consumer interest in memory-related dietary supplements, particularly among ageing patients or populations, and students seeking such supplements to enhance academic performance (Hersant et al., 2023; Miller 2022). Additionally, a study found that the longer a consumer looked at a specific claim, the more likely they were to purchase the respective product (Steinhauser et al. 2019). Furthermore, the lower the price, the higher the perceived healthiness and tastiness of the product, which in turn increases its likelihood of purchase. Thus, manufacturers may claim more for the products and add some flavour to those products to enhance taste. This may trigger another issue, as the products had more unproven claims that misled consumers. Offline products had a narrow range of claims, suggesting that offline products were more stringent in their claims for dietary supplement products. This also aligns with product labelling and health claims, which are monitored by NPRA guidelines, and the dietary supplement products must be approved by the Ministry of Health to ensure safety (National Pharmaceutical Regulatory Agency 2023).

In conclusion, from a public health perspective, the difference was significant because online platforms may have had a larger number of products and more claims. Online platforms may also contribute to greater exposure to unproven claims, raising concerns about safety issues (Ang, Ooi, Abd. Aziz, et al. 2023). Stronger regulatory oversight, consumer education, and evidence-based product validation are essential to ensure that these products deliver genuine benefits rather than unsubstantiated promises.

CONCLUSION AND IMPLICATIONS

This study provides the first systematic documentation of dietary supplements with cognitive-enhancing claims available in offline retail stores in Kuala Lumpur and on major online e-commerce platforms. The findings highlight notable differences between the two platforms in terms of product origins, dosage forms, pricing, active ingredients, and the type of cognitive-enhancing claims. Offline markets were fewer, which were mainly dominated by Singaporean products with more restricted claims. The online marketplace was saturated with products from the United States, featuring a wider range of claims, particularly related to memory and a broader price spectrum. Natural extracts and compound formulations emerged as the most common active ingredients, potentially reflecting consumer perceptions of "natural" as safer and more effective, despite limited clinical evidence.

The study's strength lies in its pioneering exploration of this under-researched area in Malaysia, offering insights that can inform both consumer awareness and regulatory oversight. Nevertheless, certain limitations should be acknowledged, including that the data were restricted to selected retailers in Kuala Lumpur and selected online platforms, the offline sample size was relatively small, products marketed through social media and official brand websites were not included, and no tools or instruments for assessment were used. Secondly, the status of product registration by the National Pharmaceutical Regulatory Agency (NPRA) was not collected in this study. These factors may limit the generalizability of findings to the wider Malaysian market.

Future research should broaden coverage to other regions and sales channels, while clinical studies are urgently needed to validate the efficacy, dosage accuracy, and long-term safety of these supplements. Policymakers may use these findings to strengthen the regulation and monitoring of health claims, particularly on online platforms. Meanwhile, industry stakeholders should ensure greater transparency and responsible marketing practices. Ultimately, protecting consumers from misleading or unsubstantiated claims is critical to safeguarding public health and ensuring that cognitive-enhancing supplements deliver proven benefits rather than unverified promises.

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