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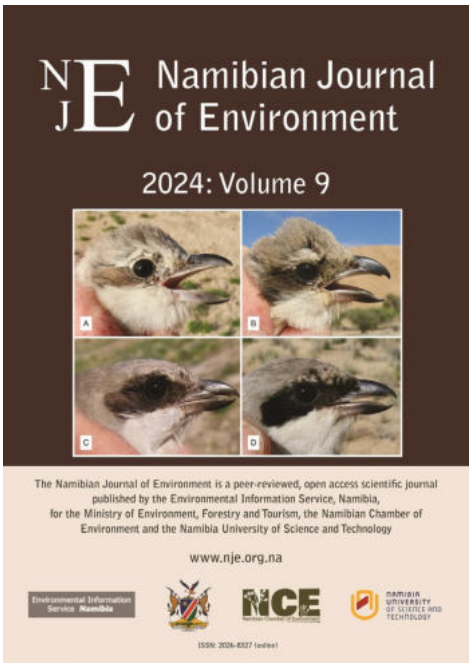

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Freshwater fish as a potential nutritional gap-filler in combating malnutrition in Namibia

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Abstract

With Namibia exporting up to 97% of the catch from marine capture fisheries, the small-scale inland fisheries resources have been touted as the community-centred solution towards ensuring food security and alleviating malnutrition in the country. Although efforts have been made over the years to address malnutrition, especially among children, nearly 90% of children under the age of five do not receive the minimum acceptable diets with adequate dietary diversity and meal frequency. Consequently, one in every five children has stunted growth. With monotonic energy-based diets prioritising caloric input over balanced nutrition, Namibian children are often deficient in micronutrients such as vitamins B2, B3, B9, calcium, and iron, all of which are found in high concentrations in freshwater fish. Additionally, fish provide other essential micronutrients such as vitamin B12, zinc, selenium, and omega-3 fatty acids that support overall health and growth. Small-sized fish or juveniles of large fish have high concentrations of these essential micronutrients, underscoring the need for further research on fisheries resource utilisation and the nutritional composition of local fish resources which hold significant potential for addressing dietary micronutrient deficiencies. This article aims to discern the potential contribution of freshwater fish in addressing malnutrition, especially amongst vulnerable groups such as children.

Keywords: diets, freshwater fish, inland fisheries, micronutrients, Namibia, stunted growth, undernourishment, wasted growth

Introduction

Namibia is a sparsely populated country in south-western Africa, with a population of 3.02 million inhabiting 826 000 km² – an average population density of 3.7 persons per km² (NSA 2024). The low population density is partly due to Namibia being the driest country in sub-Saharan Africa, with only 5% of the country receiving more than 500 mm of rainfall annually and 92% of the land classified as either semi-arid, arid or desert (Sweet & Burke 2006). Yet, agriculture remains an important sector in the country's formal and informal economy, supporting up to 70% of the population (Shiimi *et al.* 2012). Despite this, 70% of the required staple food in Namibia (maize and pearl millet) is imported from neighbouring countries like South Africa, Zambia and Angola; highlighting the difficulties of agricultural food production in dry climatic conditions (Shifiona *et al.* 2016, Mupambwa *et al.* 2019). As such, Namibia faces a dire malnutrition situation and is not on course to attain most of its global sustainable development goals related to nutrition (GNR 2022). It was envisaged that by March 2024, about 26% of the Namibian population will be facing high levels of acute food insecurity and will require urgent government intervention (IPC 2023). The World Health Organization (WHO) defines malnutrition as a "deficiency or excessive intake, imbalance of essential nutrients or impaired nutrient utilisation resulting in insufficient dietary energy levels to maintain a normal active and healthy life" (WHO 2023). In developing countries like Namibia, malnutrition (which includes all forms of poor nutrition such as undernutrition and overnutrition) is a big concern. Undernutrition (deficiency in important nutrients) is typically the most common form of malnutrition, and primarily expresses itself in the form of stunted growth (children being too short for their age) and/or wasted growth (children's weight being too low for their height, WFP 2024).

Capture fisheries in Namibia are essential sectors with the potential to improve food security and economic growth. In 2020, the marine sector contributed NAD 6.86 billion of the NAD 10.58 billion (65%) Gross Domestic Product (GDP; MFMR 2021). However, the market is predominately international, with as much as 97% of the marine capture exported in 2020, contributing 14.3% of the total country export (MFMR 2021). Freshwater inland fisheries and aquaculture have been regarded as the community-centred solution towards ensuring food security and alleviating malnutrition in the country (GRN 2002, Hackenberg *et al.* 2022, Iitembu *et al.* 2022). The north-eastern part of the country has a greater concentration of perennial rivers and high rainfall compared to the rest of the country, with three of the five Namibian perennial rivers (Kavango, Zambezi and Kwando), and over 100 000 people depending on inland fisheries activities (Sweet & Burke 2006, Tall & Failler 2012). Yet, a considerable portion of the population in each of the north-eastern regions of Kavango East and Kavango West are classified as stage 4 under the Integrated Food Security Phase Classification, indicating an urgent need for intervention to recover from food insecurity (IPC 2023). With the reported high concentration of essential micronutrients, the adaptive management and sustainable utilisation of freshwater fish could be pivotal in counteracting malnutrition through increased freshwater fish consumption (Gronau *et al.* 2018, Nölle *et al.* 2020, Hackenberg *et al.* 2022).

This review aims to pinpoint the potential contribution of freshwater fish in helping combat malnutrition in Namibia, especially among children - a group very vulnerable to undernourishment.

Overview of malnutrition in Namibia

Malnutrition in Namibia has only started gaining scholarly attention in recent years, with studies directed towards describing the prevalence of this condition (NAFIN 2010, Mwilima 2018, GNR 2022, Johannes 2024). Much of the earlier estimates of both poverty and malnutrition were based on the Institute for Public Policy Research's (IPPR) research into the trends of poverty and inequality in post-independence Namibia. This was published in a series of surveys called the Namibia Household and Income Expenditure Survey (NPC 1994) - updated in 2015 - and the National Demographic and Health Survey (MoHSS & ICF International 2014). In addition to these, Misihairabgwi and Rennie (2012) documented the reports on nutritional inequality in Namibia and abroad. Overall, the prevalence of malnutrition in Namibia was found to be high among both the younger and older age groups, with 45% of the 12–18 years and 32% of the 46–66 years being undernourished as of 2012 (Misihairabgwi & Rennie 2012). Amongst children less than five years of age, nearly one in three children (28%) in Namibia had stunted growth, whilst 9% were physically wasted in their growth. Similar statistics were also reported by Mwilima (2018) and these prevalences had been increasing since 1992 (Mwilima 2018).

Despite important progress in efforts to eradicate malnutrition in Namibia, recent estimates indicate that further interventions are necessary to effectively address this issue (Misihairabgwi & Rennie 2012, Johannes 2024). In 2019, it was reported that about 288 840 (87%) of the children in Namibia under the age of five did not receive the minimum acceptable diets with adequate dietary diversity and meal frequency (Shikongo 2019). Most recently, a systematic review of the prevalence of malnutrition among Namibian children revealed an improvement from historical highs. The prevalence of malnutrition declined to 17.1% in 2021 for the whole population, whilst one in five (approximately 72 000) children in Namibia are stunted, with 43% of the current adults having been stunted in their earlier development and therefore unlikely to attain their full growth potential (Johannes 2024).

Geographically, the prevalence of malnutrition in Namibia varies among the 14 administrative regions of the country. Regions with low social and economic indicators such as low income, low level of education and high population density, especially in northern to north-eastern Namibia tend to have a higher prevalence of malnutrition (Misihairabgwi & Rennie 2012). In relation to the prevalence of stunting, Ohangwena (36.5%) and Omusati (39.4%) regions, which are among the north-central regions where 43% of the country's population occupies only 7% of the total land area, often record the highest levels of stunting among children under the age of five (Mwilima 2018, Fujimura *et al.* 2022, Johannes 2024). Similarly, vulnerability to food shortages is highest in Kavango East and Kavango West regions, where 92% and 89% of the population per region is facing food shortages, respectively (Mwilima 2018). Likewise, these two regions are also associated with a high prevalence of both stunting (19.5% and 15.9%) and wasting (5.7% and 6.2%, Fujimura *et al.* 2022).

The prevalence of undernourishment in Namibia also varies among gender groups. The prevalence of stunting is 23.6% and 18.1% among Namibian male and female children under the age of five (Fujimura *et al.* 2022). Among the whole population at large, Misihairabgwi and Rennie (2012) reported fewer females (25%) to be underweight compared to males (32%) based on their Body Mass Index (BMI; Misihairabgwi & Rennie 2012). However, among children under the age of five in Namibia, female children (4.6%) experienced lower weight for their height (wasted growth) compared to male children (3.8%; Fujimura *et al.* 2022). However, broad generalisation of prevalence data should be done with some levels of caution, as different estimation methods may yield different values, especially in developing countries such as Namibia where the quality of the estimation data often is of poor quality, when available (Fujimura *et al.* 2022).

Nutritional composition of staple food in Namibia

A typical Namibian diet is mainly composed of cereal grains like pearl millet (locally known as mahangu) and maize, which are often consumed with red meat and seasonally with leafy greens such as wild spinach, and milk (Vähätalo *et al.* 2005, Singlinger *et al.* 2019). On average, the commercial per capita consumption of maize, which is used to supplement mahangu when preparing meals, is 44 kg per year, whilst mahangu is 29 kg per year – resulting in mahangu accounting for only 20% and maize 33% of the national cereal consumption (Shifiona *et al.* 2016). Mahangu is chiefly produced on a subsistence level for human consumption across the country (hence low importation), whilst the local subsistence production of maize is low, frequently necessitating commercial importation to satisfy local demands (NAB 2023).

As a collective, Namibia can be described as a meat-eating nation, with a per capita consumption of around 50–60 g/day, well above both the WHO-recommended level of 15 g/day and the world average of 41.8 g/day (Table 1; Singlinger *et al.* 2019). In addition, due to unfavourable climatic conditions and the relative unaffordability of imported products, Namibians generally have limited access to fruits and vegetables (Vähätalo *et al.* 2005, Singlinger *et al.* 2019).

Table 1: *Consumption levels of various Namibian food groups and their recommended levels by the World Health Organization (WHO).*

Food Groups	WHO Recommended Levels	Namibian Levels [a]	Status
Whole grains	125 g/day	50-199 g/day	Equal
Meat	15 g/day	50-60 g/day	Excess
Vegetables	400 g/day	40 g/day	Deficit
Fruits	300 g/day	30-74 g/day	Deficit

[a] Namibian consumption level adopted from Singlinger *et al*. (2019).

Mahangu and maize are among the most common crops in the country (climate permitting). Both predominantly contain high carbohydrate content, making them an ideal source of dietary energy. The considerable carbohydrate levels in these staple grains contribute significantly to their gross energy values, with mahangu providing around 1 700 kJ/kg and maize providing between 1 398 and 1 477 kJ/kg (Okoruwa & Kling 1996, Bathla *et al.* 2020, Hassan *et al.* 2021). Meat is chiefly a protein-dense food, providing around 23 g of protein per 100 g (Williams 2007, Wyness 2016). Availability and nutritional efficiency have made porridge (made from a mixture of maize and sometimes mahangu) and meat a mainstay in the diets of especially children as it is used primarily for the growth, repairs and maintenance of body tissues (Endrinikapoulos *et al.* 2023). This makes them essential in the Namibian diets where caloric intake seem to be prioritised over balanced nutrition.

As a result of the monotonic energy-based diets, there have been key findings highlighting the dire lack of essential nutrients in Namibian diets, especially among children – a group with a high prevalence of malnutrition. In a study that employed various observational and biochemical methods, Jooste *et al*. (1994) investigated the nutritional status of 380 school-going children in north-eastern Namibia. Overall, it was reported that their diet lacked sufficient calories, as it often only fulfilled 39% and 45% of the recommended daily intake by the WHO, for girls and boys, respectively (Jooste *et al.* 1994). Furthermore, their diets were deficient in essential micronutrients and minerals such as vitamin A, riboflavin (B2), nicotinic acid (B3), vitamin B6, folic acid (B9), ascorbic acid (vitamin C), vitamin E, iron (Fe), calcium (Ca) and iodine (I) (Jooste *et al.* 1994, Vähätalo *et al.* 2005).

Although the available nutritional data as discussed in Jooste *et al*. (1994) and Vähätalo *et al*. (2005) are from the mid-1990s and 2000s, contemporary social and environmental issues do not provide a positive outlook, suggesting little improvement, or a worsened situation. For instance, the Namibian population more than doubled from 1.40 million in 1991 to 3.02 million in 2024 (NSA 2024). Yet, in the context of climate change, there has been an increased intensity, frequency and duration of drought events in Namibia over the last decade, further constraining the sustenance of an already-dry country (Liu & Zhou 2021). Currently, Namibia is experiencing one of its worst droughts in recent memory, which has resulted in country-wide crop failures, severe food insecurity and the declaration of a nationwide state of emergency. Nutrient sources that could be relied upon in the 1990s are becoming increasingly vulnerable to the pressures of climate change and population growth, suggesting the need for nutritional alternatives.

Persistent environmental factors (droughts and floods that disrupt agricultural production) and socio-economic factors (high unemployment rate) limit access to diverse food sources, which further exacerbates undernutrition in Namibia (NPC & WFP 2021). The deficiency in micronutrients is not always easily measured, and when they become clinically evident it is often too late and accompanied by disturbances in physical growth, intellectual development and immunological functions (NAFIN 2010). Namibian population suffers from various diseases caused by micronutrient deficiencies, such as goitre (caused by iodine deficiency), xerophthalmia (vitamin A deficiency), anaemia (iron deficiency), and pellagra (vitamin B3 deficiency; FSNC 1995). Although the government has taken significant strides to increase the consumption of deficient micronutrients, such as through salt iodisation programs and the distribution of vitamin A supplements at primary health care centres – other deficiencies are more complex in their origin, making them difficult to address individually. Animal food sources, such as freshwater fish, often have a variety of micronutrients in forms readily available for human absorption, making them ideal for combating micronutrient deficiencies as a whole, rather than individualised supplementation programs in non-endemic parts of the country.

Nutritional value of fish and contribution towards mitigating undernutrition

The high concentration of essential nutrients in fish, coupled with the high availability and accessibility in natural and rural systems all around the world, makes fish a key asset in combating nutritional ailments worldwide (McIntyre *et al.* 2016). Although the nutritional profiling of freshwater fishes is entirely lacking in Namibia, a study has been done in neighbouring Zambia where the composition of common freshwater fishes of different sizes and preparation and consumption methods was profiled (Table 2; Nölle *et al.* 2020). Freshwater fish were found to often contain high protein and moderate fat contents, around 17.38 g per 100 g and 3.52 g per 100 g, respectively, with small fish generally having higher fat content than large fish. Fish are also known for their high fatty acid composition, especially the long-chain polyunsaturated omega-3 fatty acids that have a low synthesis in the human body, hence their supplementation is often recommended as the body cannot sufficiently manufacture them. These essential long-chain polyunsaturated fatty acids such as eicosapentaenoic

Table 2: *Common nutrients found in freshwater fish, along with their recommended daily intake (RDI) for children (1-3 years) and pregnant and lactating women (PLW).*

Nutrient	Units	Recommended Daily Intake (RDI) [a]		Content per 100 g edible portion [b]			Mean content
		1–3 years	PLW	Small fish (3.7–10.0 cm)	Medium fish (10.3–18.7 cm)	Big fish (20.9–46.1 cm)	
Proximate							
Protein	g/day	13	71	18.9	17.8	17.5	18.1
Fat	g/day	–	–	4.2	5.1	2.8	4.0
Fatty acid composition							
EPA	%	–	–	1.3	0.4	0.6	0.8
DHA	%	0.1	0.2	2.8	1.6	3.1	2.5
Vitamin composition							
Vitamin B2 (Riboflavin)	mg/day	0.5	1.4–1.6	0.1	0.2	0.1	0.1
Vitamin B3 (Niacin)	mg/day	6	18–17	2.5	2.7	2.92	2.7
Vitamin B6 (Pyridoxine)	mg/day	0.5	1.9–2.0	–	–	–	–
Vitamin B9 (Folates)	µg/day	160	600–500	15.5	11.9	12.9	13.4
Vitamin B12	µg/day	0.9	2.6–2.8	10.6	2.7	2.7	5.3
Mineral composition							
Calcium (Ca)	mg/day	500	1 200–1 000	1 029.6	250.9	31.8	437.4
Iron (Fe)	mg/day	5.8	15	5.9	0.9	0.5	2.4
Zinc (Zn)	mg/day	4.1	5.5–9.5	5.2	1.5	0.8	2.5
Potassium (K)	mg/day	–	–	265.1	260.4	279.3	268.3
Magnesium (Mg)	mg/day	60	–	44.2	26.2	24.3	31.5
Selenium (Se)	µg/day	17	28–35	36.4	53.2	35.8	41.8

[a] Derived from FAO and WHO (2001) and WHO *et al*. (2002).
[b] Derived from Nölle *et al*. (2020).

acid (EPA) and docosahexaenoic acid (DHA) play a critical role in the cognitive abilities and brain development of a child, especially during the first 1 000 days of life (Longley *et al.* 2014). In Zambian freshwater fishes, the concentration of the EPA ranged from 0.05% in tilapias to 2.79% in small-sized fishes such as kapenta, while the DHA ranged between 0.16% in S*ynodontis* species to 13.39% in cichlids (Nölle *et al.* 2020, Estiasih *et al.* 2021).

Fish also have a high concentration of essential minerals such as calcium (304 mg per 100 g), iron (1.76 mg per 100 g), and zinc (1.9 mg per 100 g); with these concentrations typically being highest in smaller-bodied fishes which are consumed whole, with bone, scales, viscera and head intact (Larsen *et al.* 2000, Nölle *et al.* 2020). In essence, much of these minerals are often lost as by-products when only the preferred parts (often fillets) of large fish are consumed. In Zambia, which shares similar river systems and fish communities with north-eastern Namibia, freshwater fishes contain high volumes of micronutrients such as vitamin B2 (Riboflavin, providing 24% of the recommended daily intake [RDI] per 100 g edible portion), vitamin B3 (niacin, 45% RDI), vitamin B9 (folate, 8% RDI), calcium (87% RDI), and iron (42% RDI); which are all deficient in the diets of malnourished children in Namibia (Jooste *et al.* 1994, Vähätalo *et al.* 2005, Nölle *et al.* 2020), underscoring the potential of freshwater fish in combating malnutrition.

Conclusions and recommendations

Although Namibia is a large country with a relatively small population, alarming statistics paint a worrying picture of the current and future nutritional status of the population, especially among vulnerable groups such as children where one in five are experiencing stunted growth. About 26% of the Namibian population is food insecure and needs rapid intervention from the government for assistance (IPC 2023). With diverse freshwater resources, including fish, particularly in north-eastern Namibia, this should not be the case if the fish resources are sustainably managed. Yet, up to 79% of communities in north-eastern Namibian are unable to afford and access nutritious and daily survival diets (NPC & WFP 2021). The current drought (2023/4), and its impact on depleting the resource base relied upon by Namibians, might make a bad nutritional situation even worse (Brown & Thomson 2024). As we have outlined above, the consumption of freshwater fish, especially the smaller-sized fish, has huge potential in providing key nutrients that are currently deficient in staple foodstuffs, hence lacking in diets.

Efforts to address the nutritional deficiencies in Namibian diets should be coupled with the comprehensive nutritional profiling of local freshwater fish species from Namibian rivers. Specifically, further research should prioritise the

quantification of the nutrients prevalent in freshwater fish but deficient in the diets of Namibian children. Additionally, attention should be given to nutrients found in fish in high concentrations that are not reported to be deficient in diets but are recognised for their beneficial effects on human health.

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