Original Research Article

The Role of Micronutrients in Immune Function and Health: Insights from Healthcare Professionals on Multivitamin-Multimineral Supplementation

Abstract

Aims: Despite the inconsistent findings in existing literature, micronutrients such as vitamins A, C, D, and E, and trace elements like zinc and selenium, are crucial for sustaining immune competence. The study aimed to capture valuable insights from healthcare professionals (HCPs) about their perceptions with a multivitamin multimineral supplement (MVMS) in making informed decisions regarding the use, benefits, applicability and integration in clinical practice.

Study Design: A retrospective real-world data survey.

Place and Duration of Study: Across India, from September 10 to October 16, 2024.

Methodology: A digital survey platform with a 23-question close ended questionnaire was developed, that provided a secure, user-friendly interface, and was shared as a link with clear instructions and objectives among 250 HCPs of different specialities. Upon completion, data obtained was collated and compiled into a comprehensive report, highlighting the key trends, insights, and actionable findings, and subsequently recommendations were developed, focusing on clinical performance across acute illnesses.

Results and Discussion: This study explores the growing evidence linking micronutrients to immune function and health, and focuses on the role of MVMS in enhancing immune responses and overall well-being. The HCPs reported calcium deficiency in 61.2% of women, while fatigue emerged as the most common and debilitating symptom of iron deficiency, reported by 80.4% HCPs. 98% of HCPs agreed that MVMS helps reduce fatigue and enhances energy within 2-3 weeks, while 95% confirmed its role in accelerating recovery from acute illnesses. Furthermore, 94.4% of HCPs acknowledged that MVMS helps boost immunity, reduces the frequency of illnesses, improves productivity and quality of life. Notably, 82% of HCPs recognized that MVMS helps in speeding the recovery from illnesses in their patients by 50%. 89.6% of HCPs believed that MVMS helps their patients gain energy in 2-3 weeks/a month of daily consumption by upto 50%. Beyond physical health, 87.6% of HCPs recognized that MVMS helps improve mental alertness, stress, enhances cognitive and mental health, and aspects of daily functioning by reducing mental fatigue and improving stamina. Additionally, 94.4% of HCPs affirmed that MVMS helps patients return to their normal routines faster, typically within 2-3 weeks, reducing infection rates and absenteeism.

Conclusion: During acute illness, a depleted state of micronutrients is observed, thus adding MVMS may help restore the depleted micronutrients and support immune health. MVMS has emerged as a scientifically validated intervention to address micronutrient deficiencies, helps contribute to improve immunity, accelerate recovery, improve energy levels, reduce fatigue, and support cognitive and mental health. The insights obtained offer valuable guidance for individualized patient care and highlights the importance of micronutrient supplementation in supporting immune health. The balanced composition of 12 vitamins, 2 minerals, 5 trace elements, and an amino-acid, was well-tolerated across diverse populations, making it an integral component of preventive and therapeutic healthcare strategies.

Keywords*: Multivitamins and multiminerals, acute illness, immunity, improved recovery, energy gain, reduce fatigue*

1. INTRODUCTION

Nutrition is the strongest and most adjustable component in reducing the burden of disease throughout the lifespan of an individual. Adequate and balanced nutrient intake along with effective metabolism provide the substrates for the normal physiological functions of the human body (Kiani AK, et al., 2022). Micronutrient deficiencies mostly occur when nutrient intake fall below the recommended levels dietary intake but still remains above the level of clinical deficiency. Thus, micronutrient deficiencies result in clinical symptoms that are overt in nature and often cause hidden or subclinical symptoms, that are difficult to detect. An energy-rich but nutrient-deficient diet can exacerbate these deficiencies, leading to "hidden hunger" (Kiani AK, et al., 2022).

Prevalence and Consequences of Micronutrient Deficiencies

Approximately two billion people suffer from deficiencies in one or more micronutrients, such as iron, folic acid, and vitamin B12, across the globe. In India, nutritional deficiencies solely contributed to about 0.5% of total deaths in 2016. About a staggering 70% of the Indian population consumes less than 50% of the recommended dietary allowance (RDA) for micronutrients. (Maggini, et al., 2018; Gonmei, et al., 2018; Gombart, et al., 2020) Micronutrient deficiencies are generally caused by insufficient intake or impaired absorption due to a compromised state such as infections or inflammation, are prevalent across all age groups in India (Maggini, et al., 2018; Gonmei, et al., 2018; Gombart, et al., 2020). A major concern is vitamin B12 deficiency, with a prevalence being reported as 35%, and was found to be significantly higher among the vegetarians (54%) compared to the individuals on a mixed diet (31%). Additionally, only 40% of the population meets the 70% of the RDA for B12 (Shivaprasad, et al., 2016).
Approximately 80%–85% of the Indian population suffers from varying degrees of vitamin D deficiency, often coupled with widespread dietary calcium deficiency, despite adequate exposure to sunlight (Harinarayan, et al., 2021). Vitamin D plays a crucial role in pain regulation, influencing hormonal, neurological, and immunological factors, and its deficiency is linked to chronic pain conditions such as headaches, abdominal pain, musculoskeletal pain, back pain, fibromyalgia, and muscle weakness and spasms (Shipton, et al., 2015).Iron deficiency is another major concern in the Indian population. As per the National Family Health Survey-5 (2019-2021), a staggering 57.2% of Indians aged between 15-48 years were reported to be anemic (Givens, et al., 2024).

Fatigue, lack of energy, lack of concentration, and dyspnoea and/or weakness are reportedly the frequent manifestations of iron deficiency (Weckmann, et al., 2023). Evidences have showed that subclinical deficiencies of essential vitamins and minerals are linked with impaired immunity, fatigue, and cognitive deficits and are frequently overlooked owing to their non-specific nature, thus delaying clinical intervention (Tardy, et al., 2020).

Micronutrient deficiencies can accelerate the natural aging processes, reduce the immune defence, eyesight-hearing, and cognitive performance. Low plasma levels of vitamin B_{12} and folate, accompanied by elevated homocysteine levels, are independent predictors of mortality risk in older adults. Vitamin B_{12} deficiency could contribute to the development of peripheral nerve damage with numbness of the extremities, pain, restless legs, difficulty walking, balance problems, and diminished quality of life (Gombart, et al., 2020; Annweiler, et al., 2017; Tulchinsky, 2010).
At the onset of an acute infection, symptoms can manifest as fever, nausea, poor appetite, cough, abdominal pain, vomiting, diarrhea, and headache (Hulme, et al., 2017). Fatigue is a highly prevalent (63%) and debilitating symptom, often preceded by an acute infectious episode in certain patients (Hulme, et al., 2017; Bennett, et al., 1998). Sleep disturbances, pain, myalgias, arthralgias, and headaches are also some of the commonly experienced symptoms during the post-infectious stage (Tackey, et al., 2024). An observational cohort study in Africa, showed that 38% of individuals experienced long-term musculoskeletal pain, while 35% reported persistent headaches (Tackey, et al., 2024). In some cases, individuals may experience neurological symptoms and extended bouts of diarrhea apart from fever, abdominal pain, nausea and vomiting (Hulme, et al., 2017). Infections can lead to a reduced intake of food, impairment of nutrient absorption, and increased nutrient

requirements. This in turn reduces the caloric intake, and this caloric suppression can result in both decreased macro- and micronutrient intake. In regions where malnutrition and infectious diseases are widespread, the interplay between nutritional status and the acute-phase response is particularly evident. The acute phase response triggered by infection elevates energy expenditure to generate fever and accelerates the catabolism of macronutrients. Additionally, infections suppress the appetite, reduce absorption of nutrients, and can also increase the nutrient requirements by promoting direct loss of micronutrients. Conversely, malnutrition exacerbates vulnerability to infections by compromising both the innate as well as the adaptive immune responses. Addressing this bidirectional relationship necessitates integrated interventions that are aimed at improving the nutritional status and mitigating the burden of disease in the developing regions (Bresnahan, et al., 2014).

Micronutrient Deficiencies and Major Deficiency Disorders

Vitamin B_{12} deficiency, linked to *H. pylori*-induced gastric atrophy, causes megaloblastic anemia. Folate deficiency is associated with neural tube defects, cardiovascular diseases, and depression. Thiamine deficiency causes beriberi; riboflavin deficiency leads to fatigue and impaired iron absorption; niacin deficiency results in pellagra; and vitamin B_6 deficiency causes anemia, neurological disorders, and elevated homocysteine (Tulchinsky, 2010). All B vitamins are vital for cellular energy production, where any deficiency disrupts metabolism (Tardy, et al., 2020). Vitamin A deficiency increases infection risk, alters immunity, and raises the likelihood of diarrhea (Huang, et al., 2018).

Among the key minerals, iron deficiency results in anemia, reduced learning and work capacity, and increased maternal and infant mortality, as well as low birth weight. Zinc deficiency may contribute to impaired growth and decreased resistance to infectious diseases while calcium deficiency can lead to decreased bone mineralization, rickets, and osteoporosis. Selenium deficiency is associated with cardiomyopathy and an increased risk of cancer and cardiovascular diseases (Tulchinsky, 2010). Fatigue, lethargy, staggering, muscle cramps, and loss of appetite are some of the common manifestations of magnesium deficiency and can have a substantial impact on physical performance (Tardy, et al., 2020). Individuals with acute illnesses may be prone to developing chromium deficiency, as, acute illnesses reduce the availability of circulating chromium, which may cause altered glucose metabolism (Berger, et al., 2022).

In the United States, Canada and Europe, about 35% individuals are deficient in one or more micronutrients. Inadequate intake of essential micronutrients such as vitamin C, zinc, and vitamin D has been associated with increased vulnerability to respiratory infections and impaired immune function. Lower intake of vitamin C is associated with a higher risk of pneumonia and severe infections of the respiratory tract, while zinc deficiency may lead to a compromised immune function. Similarly, low intake of vitamin D or lower levels may be associated with a higher risk of acute respiratory tract infections (Fantacone, et al., 2020).

A cross-sectional study by; Wang et al,. in the elderly Ecuadorian population found that deficiencies in micronutrients such as folic acid, zinc, and vitamins C, D, B_6, or B_{12} were linked with recent episodes of common cold or pneumonia. Additionally, lower levels of zinc was associated with increased vulnerability towards infections such as malaria, diarrhea, and acute lower respiratory infections. The study demonstrated that supplementation with multivitamins and minerals reduced the frequency, duration, and severity of acute respiratory infections. Even mild micronutrient deficiencies can negatively impact the immune system of otherwise healthy adults (Wang, et al., 2019).

The Role of Balanced Nutrition and Multivitamin-Multimineral Supplements in Optimizing Health

Optimal immune function relies mainly on adequate nutrition as it ensures a steady supply of macro- as well as micronutrients that are vital for an immune response to occur. Key micronutrients including several vitamins such as A, C, D, E, B_2, B_6, B_{12}, folic acid, vitamin D, and minerals such as calcium, iron, selenium, magnesium, zinc, copper are all essential for immune competence. A poor state of

nutrition compromises the immune response, while increasing susceptibility to infections (Maggini, et al., 2018; Gonmei, et al., 2018; Gombart, et al., 2020). The complexity of the immune system necessitates the need for multiple specific micronutrients, each playing synergistic roles in different stages of the immune responses (Table 1) (Saboo, et al., 2024).

Table 1: Role Of Various Micronutrients in the Human Body	
Vitamin/mineral	Role in the human body
Vitamin B1	Antioxidant; inhibits oxidative-stress-mediated stimulation of NFκB.
Vitamin B2	Anti-inflammatory; cofactor for enzymes.
Vitamin B6	Regulates intestinal immunity; maintains NK cell cytotoxicity activity.
Folate	Maintains NK cell cytotoxicity activity.
Vitamin B12	Immunomodulator for cellular immunity.
Vitamin C	Maintains redox homeostasis; regenerates antioxidants to the active state.
Vitamin E	A fat-soluble antioxidant that protects against free radicals enhances IL-2 production, decreases prostaglandin production.
Vitamin D	Increases the oxidative potential of macrophages; reduces the expression of proinflammatory cytokines.
Zinc	Maintains/enhances NK cell cytotoxicity activity; plays a role in the growth and differentiation of immune cells; enhances phagocytic activity of peritoneal macrophages.
Selenium	Selenoproteins are important for antioxidant defence.
Iron	Bacterial killing by neutrophils, components of enzymes critical for immune cell functioning.
Magnesium	Co-factor for enzymes and stabilized nucleic acids, involved in DNA replication and repair.
DNA, deoxyribonucleic acid; IL-2, interleukin-2; NFκB, nuclear factor kappa B; NK, natural killer	

A growing body of evidence demonstrated significant correlations between nutrients and immunity, particularly that micronutrients can positively modulate immune responses. Micronutrients enhance resistance to illness and can help redirect the inflammatory response to benefit the individual. In humans with a single nutrient deficiency, the roles of certain vitamins, minerals, and trace elements (vitamins A, C, D, and E; folic acid; vitamins B_6 and B_{12}; iron; riboflavin; selenium; and zinc) are essential for sustaining immunocompetence and have been well-established. Restoring the diet with deficient micronutrients has been shown to restore the immune function and thus increase resistance to infections (Alpert, 2017). A balanced combination of multiple vitamins and minerals offers numerous health benefits, including reduced incidences of fatigue, accelerated recovery from both acute and chronic illnesses, as well as enhances the mental health and physical stamina. These supplements help maintain consistent energy levels, thus ensuring productivity throughout the day. Additionally, the long-term use of multivitamin and minerals supplement is also associated with sustained health benefits, supporting overall well-being of the individuals. Importantly, they are safe and well-tolerated, which makes them a reliable choice for individuals to optimize their health, vitality and improved quality of life (Tardy, et al., 2020; Saboo, et al., 2024).

The current Indian Guidelines, National Institute of Nutrition for Micronutrient Supplementation has recognized the need for adequate intake of multiple vitamins, minerals, and antioxidants across different age groups. The European Society for Parenteral and Enteral Nutrition also recommends that patients receiving enteral/parenteral nutrition should receive adequate amounts of vitamins and all the essential trace elements right from the initiation of nutritional support. The supplements with adequate micronutrients shall be provided orally or enterally, if this can be done safely and effectively (Alpert, 2017).

Evidence on the effectiveness of dietary supplements, particularly a multivitamin-multimineral supplement (MVMS), has been inconsistent because no guidelines currently exist for recommending the use of MVMS, and results from randomized controlled trials about their potential benefits in

preventing/treating medical conditions are limited making it challenging for healthcare professionals to provide clear recommendations No guidelines currently exist for recommending the use of MVMS, and nutritional education and training among health care professionals (HCPs), including physicians, nurses, and pharmacists, are limited.(Blumberg, et al., 2023). To address this, a survey questionnaire was formulated, drawing upon expert opinion, to clarify the potential role of a MVMS in supporting human health.

This survey aimed to capture valuable insights from the healthcare professionals regarding their experiences with a MVMS in making evidence-informed decisions regarding the use of MVMS, highlighting its possible benefits, limitations, and considerations for different age groups of individualized patient care and the integration of MVMS into broader nutritional strategies where applicable.

2. METHODOLOGY

Study Design and Setting

This was a retrospective Real-World Data (RWD) survey conducted through a questionnaire-based approach to gather comprehensive insights from healthcare professionals (HCPs) regarding their experiences and perceptions with a MVMS (Supradyn daily). The questionnaire was designed through a comprehensive literature review on PubMed, Embase and Google Scholar focusing on existing data about multivitamin and mineral supplements. A digital survey platform was developed to host the survey, that provided a secure, user-friendly interface, and the link was shared with the HCPs via personalized email invitations containing clear instructions and objectives. Upon completion, data obtained from the surveys was collated and compiled into a comprehensive report, highlighting the key trends, insights, and actionable findings, and subsequently recommendations were developed, focusing on product improvement and clinical performance across acute illnesses, to understand better about the clinical performance based on the insights achieved.
The study aimed to support the following objectives:

1. Gain deeper insights into how MVMS can be integrated into clinical practice.
2. Identify areas of strength and potential for improvement for of MVMS based on the experience of the user.
3. Enhance the scientific prospects of MVMS from the feedback and preferences attained from HCPs along with patient requirements.

The mixed-method approach included quantitative components to provide a thorough understanding of the perspectives of healthcare professionals.
The survey was conducted from September 10, 2024 to October 16, 2024, using an online platform for ease of access and broad reach across India. The study used a validated, structured questionnaire designed to align with the survey objectives and capture the real-world experiences of healthcare professionals with MVMS.

Study Population

Participants included doctors with different levels of experience and specialization, ensuring a representative sample of HCPs who regularly engage in prescribing or recommending multivitamin supplements. The study approached HCPs from diverse specialties, including general practitioners, consultant physicians, dermatologists, and ENT practitioners. A total of 250 HCPs participated in the survey, providing feedback on their clinical experiences with MVMS in promoting faster recovery in patients and overall product satisfaction. The participating doctors were evenly distributed across the country, ensuring balanced and unbiased feedback that represents diverse regional practices and perspectives across various regions.

Data Collection

Data collection was conducted via a close-ended, 23-question online questionnaire. The survey questionnaire was developed by a panel of experts focusing on usage patterns, patient outcomes,

efficacy, and suggestions for improvement. The questionnaire was contextually tailored to capture nuances of clinical practices and patient interactions specific to the Indian healthcare setting.
Before participation in the survey, an e-consent was obtained from each HCP and logged on the e-platform for documentation. The survey link was accessible to participants between September 10, 2024 and October 16, 2024, and responses were collected and securely compiled by the research team.

3. Results

A total of 250 HCPs from India representing different medical specialties participated in the study with an aim to gain their perception and experience regarding the use of MVMS in their routine clinical practice.
The total responses collected in the study assured regional participation across the country. The highest participation was from the West Zone with 70 HCPs (28%), followed by the South Zone with 63 HCPs (25%), 52 responses from the North Zone (21%), 29 from the Central Zone (12%), and 28 from the East Zone (11%). A small proportion of HCPs (8 responses, 3%) did not specify their zone (Figure 1).

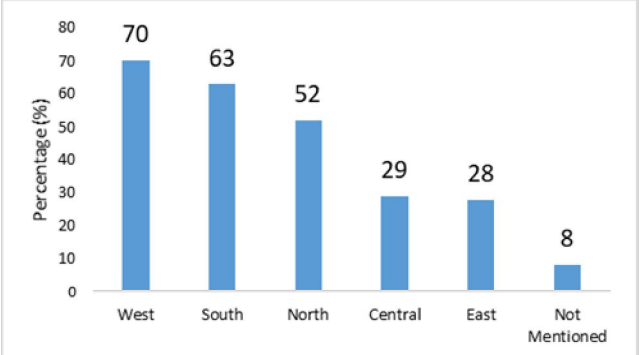

Figure 1: Participation Across Various Zones in India

Calcium Deficiency

The survey responses indicated that calcium deficiency was highly prevalent among the respondents (patients). 44.8% of HCPs observed calcium deficiency in 31%-50% of their weekly patient load, while 24.8% of HCPs observed it in about 20-30% of their patients. Notably, a significant 63.6% of HCPs reported calcium deficiency as the most commonly observed and highly prevalent indication in patients aged between 46-70 years, which could possibly be due to the age-related decline in bone density and higher calcium needs.

The survey findings showed that calcium deficiency was notably more prevalent among the females, and was reported by 61.2% HCPs, while it was reported to be 20% in male patients. With respect to symptoms, back pain emerged as the most frequently reported manifestation of calcium deficiency, affecting 50% of the respondents (125 patients), followed by muscle weakness or spasms, experienced by 46.8% (117 patients), bone pain in 31.2% of respondents (78 patients), and knee pain in 27.2% (68 patients) of respondents. About, 7.6% (19 patients) mentioned other unspecified health concerns associated with calcium deficiency.

The study findings revealed that women are likely at a higher risk of calcium deficiency, possibly because females are reportedly at a greater risk of osteoporosis as well as other calcium-deficiency related conditions, including post-menopause. Although calcium deficiency was observed only in 20% of the male patients, the findings suggest that, although men are affected less frequently, but still be considered for managing calcium deficiency related health interventions. The reported symptoms

associated with calcium deficiency may be debilitating and thus emphasizes upon the importance of proactive screening and tailored interventions to mitigate the impact on health across the genders.

Iron Deficiency

The survey responses indicated that iron deficiency was also a concern and was observed by 45.2% of HCPs in 30-40% of their weekly patient load, while 34.8% reported it in 41–60% of the cases. About 57.6% of cases were identified by the HCPs among individuals aged 36–55 years, while 19.6% of cases were reported among individuals aged 18–35 years.

A marked gender disparity was observed among the respondents, 70.4% of patients being females while male patients accounted for 11.6% of cases. Regarding symptoms, unexplained fatigue or lack of energy emerged as the most frequently reported indication of iron deficiency, affecting 80.4% of respondents (201 patients). Pale skin was the second most common sign, noted in 26% of cases (65 patients) followed by headache, particularly during physical activity, which was experienced by 17.6% (44 patients), a racing heart by 11.6% (29 patients) and 6.8% (17 patients) mentioned other unspecified symptoms.

These responses indicated that middle-aged individuals particularly the age group of 36-55 years are the most vulnerable accounting for more than half of the patients. This could be possibly due to factors such as dietary habits or comorbid health conditions. Also, women represented a significantly higher risk of iron deficiency which could possibly be because of factors such as menstrual blood loss, pregnancy-associated demands, and insufficient dietary iron intake. Although the presence of iron deficiency was less frequent in the male patients, but is not exclusive to females. The reported symptoms may be debilitating and impact the quality of life and emphasize on the importance of screening and tailored interventions to mitigate the health impacts of iron deficiency across genders and also for high-risk groups like women and middle-aged individuals.

Correlation Between Acute Infections and Micronutrient Deficiencies

A significant majority (96% combined) of HCPs agreed that there was a strong correlation between micronutrient deficiencies, including vitamin and mineral deficiencies, and the frequency of acute infections (Figure 2). This high level of agreement suggests that practitioners are aware of the potential impact of nutritional status on immune function and the ability of the body to resist and recover from infections.

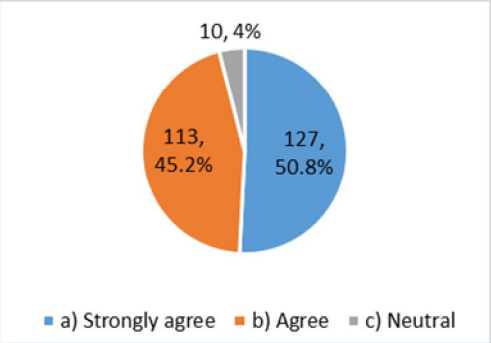

Figure 2: Response on correlation between frequency of acute infections and micronutrient deficiency

MVMS:multivitamin multimineral supplement

Primary Indication for Prescribing MVMS to Patients

66% of HCPs (165 HCPs) selected all of the options reflecting the perceived benefits of MVMS across a broad range of health conditions (general weakness, old age, viral fever, upper respiratory tract infection [URTI], lower respiratory tract infection [LRTI], dengue, malaria, pneumonia, gastroenteritis, and others).

General weakness and old age were reported by 25.6% (64 HCPs), while 16% (40 HCPs) highlighted its use during viral fever. Other reported indications included URTIs and LRTIs (8.4%, 21 HCPs),

dengue and malaria (7.2%, 18 HCPs), pneumonia (6.8%, 17 HCPs), and gastroenteritis (2.8%, 7 HCPs). A small proportion (1.6%, 4 HCPs) cited other unspecified indications (Table 2).

Table 2: Primary Indications for MVMS

Response	Count	%
All of the options	165	66
General weakness, old age	64	25.6
Viral Fever	40	16
URTI, LRTI	21	8.4
Dengue, Malaria	18	7.2
Pneumonia	17	6.8
Gastroenteritis	7	2.8
Other indications	4	1.6

MVMS, multivitamin-multimineral supplement; URTI, upper respiratory tract infection; LRTI, lower respiratory tract infection.

These findings indicate that MVMS is used for a wide array of conditions and suggest that practitioners view it as a versatile supplement for supporting overall health, particularly in cases of general weakness or when patients are at risk of multiple conditions. This broad acceptance reflects confidence in the role of a MVMS in enhancing nutritional status and possibly improving patient outcomes across a range of indications.

Perspective of HCPs on the Role of MVMS in Reducing Fatigue Levels, thus Feeling More Energetic All Day Long

The survey responses highlighted strong agreement among HCPs regarding the efficacy of MVMS in reducing the level of fatigue. A significant 59.6% of HCPs agreed that taking MVMS for a period of 2-3 weeks alleviated fatigue and enhanced overall energy levels throughout the day. Additionally, 38.4% of HCPs strongly agreed with this statement, with the total positive responses at 98% (Figure 3).

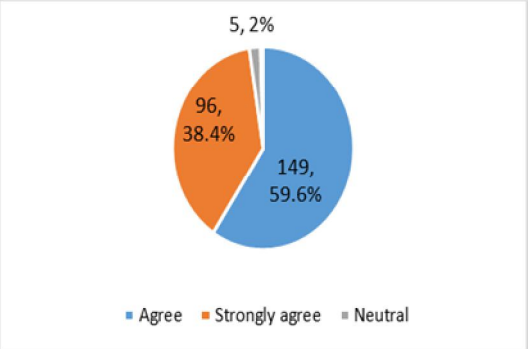

Figure 3: Response on Role of MVMS in Reducing Fatigue Feeling More Energetic all Day Long

MVMS: multivitamin-multimineral supplement

These responses highlight the confidence of HCPs that MVMS improves the energy and vitality of patients over a short-term period. The high level of agreement reflected consistent patient outcomes, suggesting that the supplement was effective in alleviating fatigue, thus supporting MVMS as a potential adjunct in managing fatigue and promoting well-being.

Role of MVMS in Accelerating Recovery from Acute Illnesses like Viral Fever, Diarrhea, Pneumonia, RTI, Common Cold and Cough

A substantial 95% of HCPs agreed that taking MVMS for a period of 2-3 weeks supports faster recovery from conditions such as viral fever, diarrhea, pneumonia, respiratory tract infections (RTIs), and common cold and cough (Figure 4).

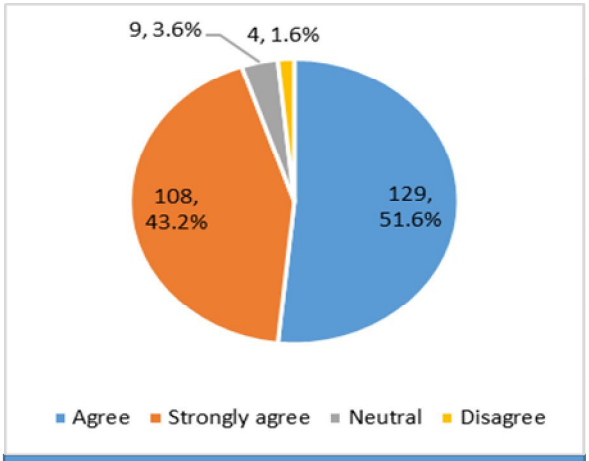

Figure 4: Response on MVMS in Accelerating Recovery from Acute Illnesses

MVMS: multivitamin-multimineral supplement

MVMS as a Daily Supplement: Facilitating Recovery, Energy Gains, and Improved Immunity

Fastening/Speeding the Recovery from Illnesses

45.2% of HCPs agreed that MVMS helps/contributes in fastening/speeding the recovery from illnesses in their patients by 50%, 36.8% of HCPs agreed that MVMS helps/contributes in fastening/speeding the recovery from illnesses in their patients by 60%, and 82% of HCPs acknowledged that MVMS helps/contributes in fastening/speeding the recovery from illnesses in their patients by 50% or more (Figure 5).

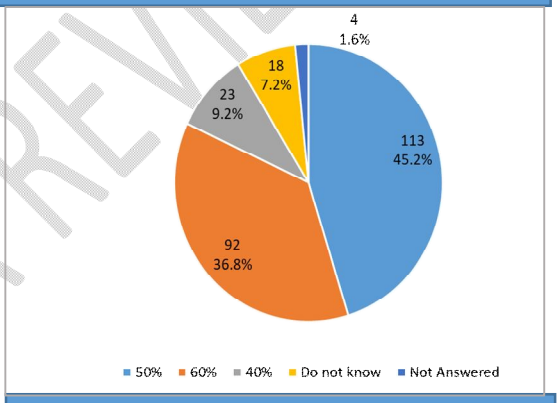

Figure 5: By What Percentage MVMS Helps/ Contributes in Fastening/Speeding the Recovery from Illnesses

MVMS: multivitamin-multimineral supplement

These findings suggest that HCPs widely perceive MVMS as a valuable adjunct in managing acute illnesses, with its micronutrient composition playing a critical role in enhancing patients' immune response and faster recovery process. This strong endorsement highlights its potential integration into treatment regimens for acute conditions.

MVMS: Facilitating Recovery, Energy Gains, and Improved Immunity

Faster Return to Routine

Survey responses revealed that 94.4% of HCPs believed that daily consumption of MVMS helped patients resume their normal routines faster, typically within 2-3 weeks. Of these, 60.8% agreed with the statement, while 33.6% strongly agreed (Figure 6). This overwhelming consensus reflects the confidence of HCPs for prescribing MVMS in expediting recovery and restoring well-being after illness.

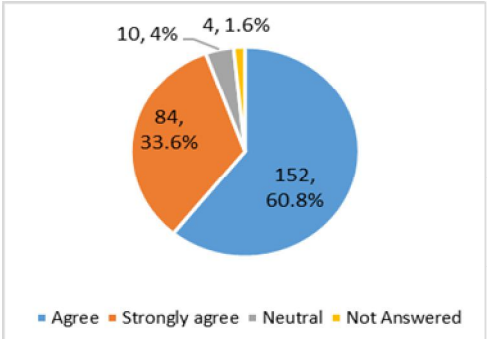

Figure 6: Response on Consumption of MVMS Helped Patients Bounce Back to Normal Routine Faster in Approx 2-3 weeks

MVMS: multivitamin-multimineral supplement

Contribution to Energy Gains

Nearly 90% of HCPs estimated that MVMS contributes at least 50% to their patients' energy improvements after 2-3 weeks of consistent use. This underscores the perceived efficacy of MVMS as a supplement for enhancing overall energy, further supporting its integration into recovery protocols (Figure 7). 48% of HCPs believed that MVMS helps their patients gain energy in 2-3 weeks/a month of daily consumption by up to 50%, 41.6% of HCPs believed that MVMS helps their patients gain energy in 2-3 weeks/a month of daily consumption by 50-75%. Hence, a total of 89.6% of HCPs believed that MVMS helps their patients gain energy in 2-3 weeks/a month of daily consumption by up to 50%.

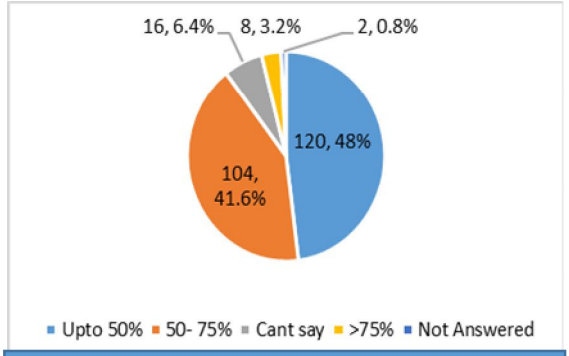

Figure 7: Response on Consumption of MVMS for Gaining Energy

MVMS: multivitamin-multimineral supplement

Boosting Immunity and Reducing Frequency of Illness

The responses indicated a strong agreement regarding the role of MVMS in boosting immunity and reducing illness frequency. A total of 94.4% of HCPs acknowledged the positive effects of MVMS on immune function, of which 63.2% agreed and 31.2% strongly agreed. The high level of agreement suggests that a significant majority of HCPs believe in the role of MVMS, which contributes to fewer missed workdays and improved productivity among patients, making it a valuable adjunct in both preventive and curative healthcare settings (Figure 8).

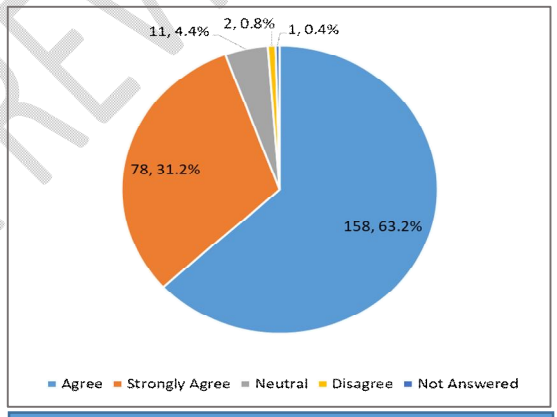

Figure 8: Response on Consumption of MVMS for Boosting Immunity, Fewer Illnesses and Reduced Absenteeism from Work

MVMS: multivitamin-multimineral supplement

Impact of MVMS on Mental Health and Physical Stamina

Enhancing Mental Alertness, Mood, Focus, Decreased Stress Levels and Overall Mental Well-Being

Survey results showed that 87.6% of HCPs believed that MVMS positively influences mental health. Of these, 52% agreed, and 35.6% strongly agreed that the supplement helped improve mental alertness, mood, focus, and overall mental health and reduced stress levels (Figure 9). The data suggests a strong belief among the HCPs in the mental health benefits of MVMS, particularly regarding its role in enhancing mental

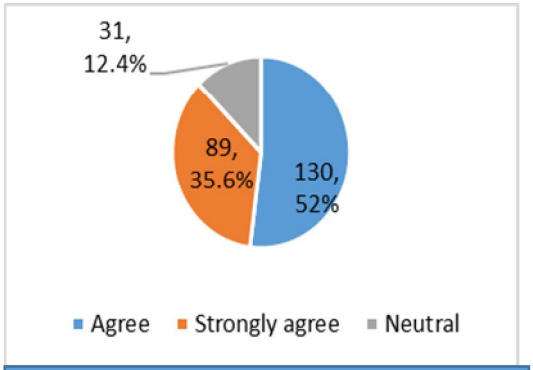

Figure 9: Response on consumption of MVMS in improving mental alertness, mood, focus, and overall mental health

MVMS: multivitamin-multimineral supplement

alertness and reducing stress. This positive perception indicates that practitioners recognize the importance of micronutrients, especially the vitamin B complex, in supporting cognitive function and emotional well-being.

Practitioners' Perception of MVMS Daily Supplement: Recommendations, Versatility, and Safety

Recommendations for a MVMS to Improve Stamina, and Stay Active and Productive All Day

Regarding physical stamina, 95.2% of HCPs confirmed that MVMS helps in enhancing their patients' ability to remain active and productive throughout the day. Of these, 58% agreed, while 37.2% strongly agreed (Figure 10). A significant majority of HCPs believed that MVMS significantly helps enhance stamina, which contributes to increased activity levels and productivity in their patients. This strong perception underscores the role of MVMS in supporting daily functioning, improving stamina and productivity all day.

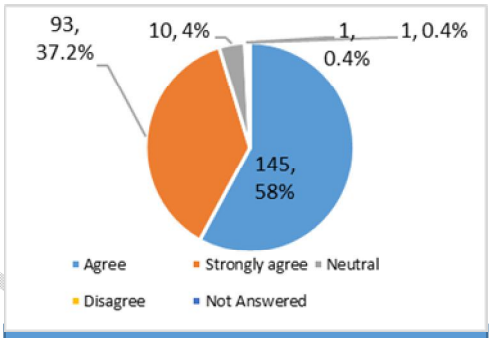

Figure 10: Response on Consumption of MVMS in Improving Stamina for Daily Productivity

MVMS: multivitamin-multimineral supplement

Strong Recommendation to Patients, Peers and Family

The response indicated that 95.6% of HCPs expressed their willingness to recommend MVMS to their patients, peers, and families. Among these, 51.6% agreed, and 44% strongly agreed. Additionally, 96.8% of HCPs endorsed MVMS as their preferred choice for addressing micronutrient deficiencies (Figure 11). The high level of agreement suggests that HCPs have confidence in the effectiveness and benefits of MVMS. This indicates a strong belief in the efficacy of MVMS and the trust that practitioners place in its ability to deliver health benefits in clinical practice.

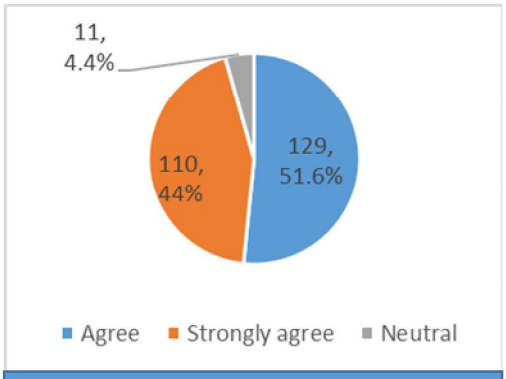

Figure 11: Response on Recommendation of MVMS to patients

MVMS: multivitamin-multimineral supplement

*A Holistic Solution Across All Age Groups (*18 to 80 years)

A significant 98% of HCPs, of which 51.6% agreed and 46.4% strongly agreed, recognized MVMS as comprehensive and suitable for individuals aged 18 to 80 years. These responses highlight the versatility of MVMS in catering to the nutritional needs of a diverse age groups. The balanced composition of 12 vitamins, 5 trace elements, 2 minerals, and 1 amino acid in MVMS has positioned it as an all-encompassing solution for preventive and supportive care (Figure 12). The majority of HCPs view MVMS as a well-rounded multivitamin that can meet the nutritional needs of diverse population. This consensus underscores the product's perceived versatility and value in supporting health across different life stages.

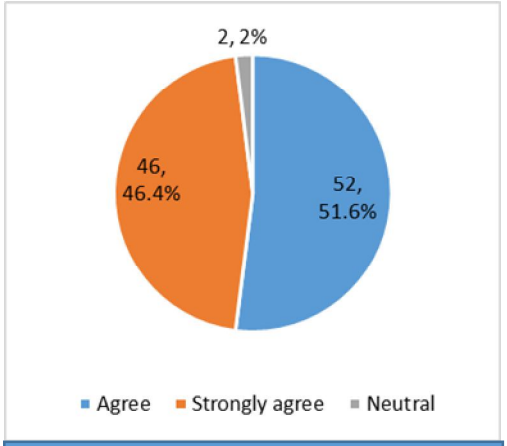

Figure 12: Response on MVMS as a Holistic Solution for all Age Groups

MVMS: multivitamin-multimineral supplement

Well-tolerated and Safe Supplement

The safety and tolerability of MVMS are key factors influencing its widespread use. A total of 95.6% of HCPs affirm its good tolerability, with 50.8% agreeing and 44.8% strongly agreeing that the supplement is generally well-tolerated with minimal or no side effects (Figure 13). This positive feedback highlights MVMS as a safe and well-tolerated option for long-term use in patient care.

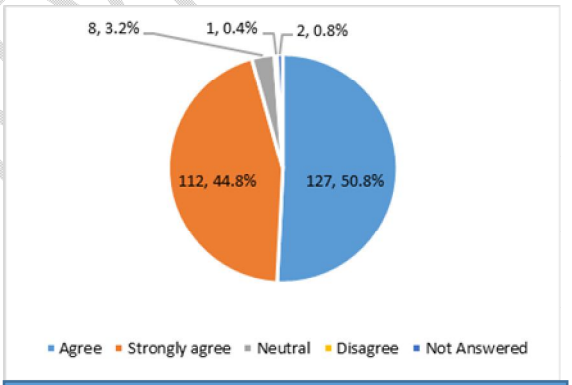

Figure 13: Response on MVMS Daily as a Safe and Well-tolerated Supplement

MVMS: multivitamin-multimineral supplement

Practitioners' Perspectives on MVMS: Effectiveness and Long-Term Benefits

Preferred Choice for Reversing Micronutrient Deficiencies

A substantial 96.8% of HCPs, of which 55.6% agreed and 41.2% strongly agreed and endorsed MVMS as their preferred choice for reversing micronutrient deficiencies (Figure 14). This high level of agreement reflects practitioners' confidence in the effectiveness of MVMS in addressing micronutrient deficiencies, positioning it as a reliable and trusted solution in clinical practice.

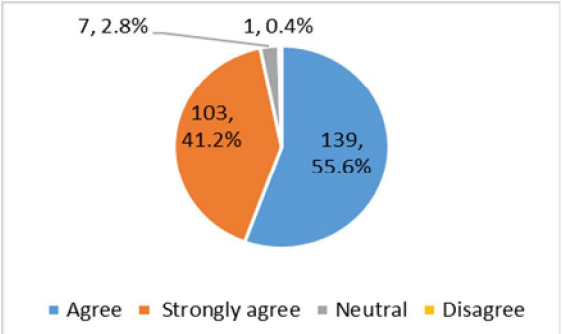

Figure 14: Response on MVMS as a Preferred Expert Choice for Recovering from Micronutrient Deficiencies

Long-term Health Benefits

The majority of HCPs (95.6%; 52.4% agreed, and 43.2% strongly agreed) believed that regular intake of MVMS for two to three months or even longer confers long-term health benefits (Figure 15). These findings reflect practitioners' confidence in the long-term value of MVMS, suggesting that it plays a key role in maintaining overall health and preventing future health issues.

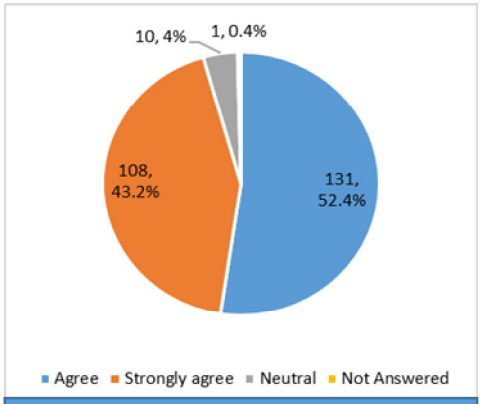

Figure 15: Response on Regular Intake of MVMS for Long-term Health Benefits

MVMS in Recovery and Treatment Plans

Role in Recovery from Acute (Including Surgeries) and Chronic Illnesses

A significant 94.8% of HCPs, of whom 55.6% agreed and 39.2% strongly agreed (Figure 16), that MVMS is beneficial when included in daily treatment plans for patients recovering from both acute illnesses (including surgeries) and chronic conditions. This indicates the perceived value of MVMS in aiding recovery, particularly through its role in addressing nutritional needs during the recovery process.

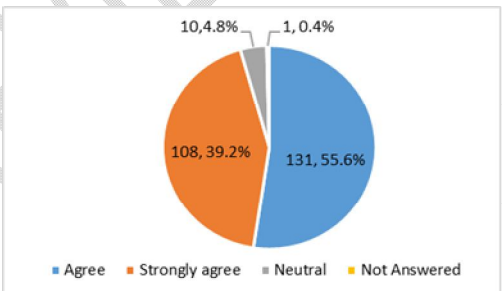

Figure 16: Response on MVMS Comprehensive Treatment Plan for Patients Recovering from Acute (Including Surgeries) and Chronic

Cost-Effectiveness Compared to Other MVMS Brands

MVMS was viewed as highly cost-effective by 88.4% of HCPs, with 51.2% of HCPs who strongly agreed and 37.2% who agreed (Figure 17). This response indicates that HCPs regard MVMS as an affordable yet valuable multivitamin supplement, offering a favourable price-to-benefit ratio when compared to other brands.

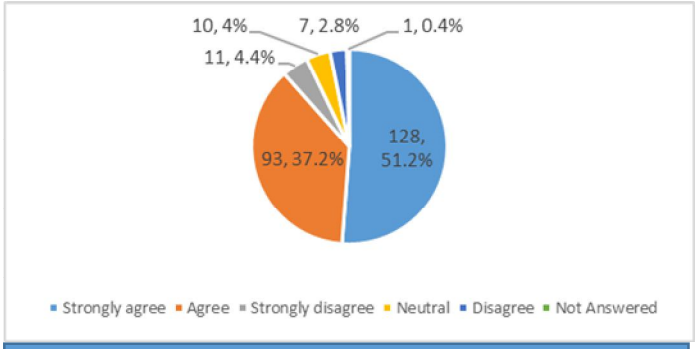

Figure 17: Response on cost-effectiveness of MVMS vs. other brands

MVMS: multivitamin-multimineral supplement

Effectiveness in Boosting Immunity, Helping Faster Recovery

Almost all HCPs (99%) agreed that MVMS was effective in boosting immunity and supporting faster recovery (Figure 18). This indicates that HCPs widely recognized that MVMS is a reliable choice for enhancing immune function and promotes quicker recuperation.

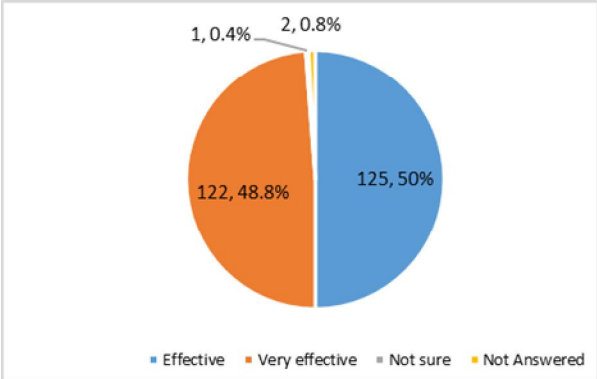

Figure 18: Response on Boosting Immunity and Helping in Faster Recovery with MVMS

MVMS: multivitamin-multimineral supplement

Satisfaction with Efficacy and Tolerability

Almost all HCPs (99%) reported strong satisfaction pertaining to the efficacy and tolerability of MVMS, indicating that the supplement consistently meets their expectations in terms of both performance and patient tolerance (Figure 19). This widespread satisfaction further validates the position of MVMS as a trusted and effective option in clinical care.

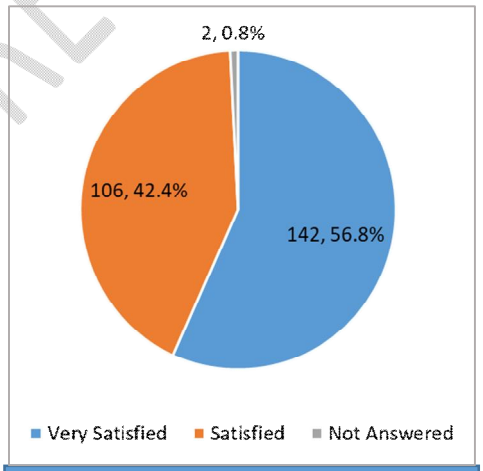

Figure 19: Response on Satisfactory Efficacy and Tolerability of MVMS

MVMS: multivitamin-multimineral supplement

4. DISCUSSION

Vitamins and minerals play a critical role in metabolism and for supporting and enhancing the metabolic processes, promoting the muscle tone, maintaining healthy skin, and improving the function of the immune and the nervous system. By aiding in the production and division of red blood cells, these micronutrients also help prevent incidence of anemia. Additionally, they also combat the effects of stress, depression, and cardiovascular diseases, thereby contributing towards a holistic well-being (Al-msaid, et al., 2023). Low serum levels of vitamins and minerals show a causal association with symptoms related to fatigue, temporary decline in physical performance such as muscle damage or impaired immune system, and impaired sleep quality. Supplementation with vitamins and minerals is effective in reducing symptoms related to fatigue, frequency of infections, muscle damage and in improving the sleep quality (Erpenbach K, et al., 2020, Rao, et al., 2024). Lee *et al*. showed that a 28-day supplementation with vitamin B complex in healthy individuals showed a reduction in physical fatigue and improvement in physical activity, energy metabolism, and exercise performance (Lee, et al., 2023). Rao *et al.* showed that multivitamin supplementation across a broader group of patients aged 16-85 years, led to a significant reduction of 30% in fatigue levels as well as substantial improvements were observed in mood and stress levels. The most pronounced benefits were observed in participants with deficiencies in vitamin D, iron, and magnesium, suggesting that

individuals with specific micronutrient deficiencies may experience greater relief from fatigue. These results strongly indicated that multivitamin supplementation is an effective intervention for alleviating fatigue and enhancing psychological well-being, particularly in individuals with undiagnosed micronutrient deficiencies (Rao, et al., 2024).

Dietary calcium deficiency is considered to be widespread globally, with published estimates suggesting that approximately 50% of the world's population has inadequate access to dietary calcium (Shlisky J, et al., 2022). Research has shown that vitamin D exerts anatomic, hormonal, neurological, and immunological influences on pain manifestation, thereby playing a role in the etiology and maintenance of chronic pain states and related comorbidity. Headache, abdominal pain, knee pain, back pain, persistent musculoskeletal pain, costochondritic chest pain, and failed back syndrome with fibromyalgia are some of the common manifestations of vitamin D deficiency (Shipton, et al., 2015).

A study by Goyal et al. showed that more women than men were found to be suffering with non-specific musculoskeletal pain. Our survey results also showed that calcium deficiency was highly evident in women and was reported by 61.2% of HCPs. Supplementation with multivitamins and multiminerals showed potential to significantly alleviate painful conditions, enhance physical activity capacity, and improve overall well-being, including physical, mental, and social health (Goyal, et al., 2021).

Before treatment, 64% of patients reported fatigue, which reduced to 34% post-supplementation. Sleep disturbances, experienced by 74% of patients, likely due to pain, reduced to 20% after supplementation with multivitamins and multiminerals, with over 52% reporting improved sleep quality. Additionally, mood disturbances such as anger, irritability, stress, low confidence, poor concentration, memory loss, and crying were reported by 72% (36 patients). Following supplementation, 48 out of 50 HCPs reported marked improvement in mood, demonstrating the benefits of addressing vitamin D deficiency in these set of patients (Goyal, et al., 2021). These findings emphasize the role of MVMS in maintaining bone and muscle health, with back pain, muscle weakness, and spasms being the most common indicators of calcium deficiency in clinical practice.

Fatigue, dyspnoea, lack of energy and concentration are commonly interpreted as indicative of symptomatic anemia and may thus play a role in diagnostic and therapeutic decisions. In participants with anemia, fatigue was reported by 34%, lack of energy by 21%, lack of concentration by 19%, and dyspnoea and/or weakness by 38% (Weckmann G, et al., 2023). The high prevalence of fatigue as a symptom (80.4%) in our survey emphasizes its importance as a key indicator of iron deficiency. Other common symptoms, such as pale skin and headache, alongside fatigue suggest that patients may experience a range of symptoms, with fatigue being the most debilitating symptom. The lower percentages for other symptoms might indicate that they are less frequently reported or less commonly associated with iron deficiency in clinical practice.

A meta-analysis by Vaucher *et al*. investigated the impact of iron on fatigue in young premenopausal women with nonanemic iron deficiency. The analysis demonstrated a significant effect of iron supplementation, leading to a reduction in complaints related to fatigue by over 60% (Vaucher P, et al., 2012). Anemia, while often linked to iron deficiency, can also result from inadequate levels of certain vitamins and minerals that are closely interconnected in metabolic and functional pathways, showing significant overlap and playing a supporting role. Deficiencies in these vitamins and minerals can disrupt red blood cell production and contribute to anemia (Tardy, et al., 2020).

The survey responses in our study revealed that 98% of HCPs agreed or strongly agreed that taking MVMS for a period of 2–3 weeks reduces fatigue and enhances daily energy levels. Additionally, 95% of HCPs confirmed its role in accelerating recovery from acute illnesses such as viral fever, common cold and cough, pneumonia, and RTIs, highlighting the importance of micronutrients in strengthening immunity and facilitating faster recovery. Dodd *et al*. investigated the impact of a single dose MVM supplementation for 4 weeks on subjective ratings of ‘fatigue/stress’, substrate metabolism and blood biomarkers of damage, inflammation, cell oxidation and antioxidant activity as a consequence of increasingly effortful incremental exercise, and during metabolically demanding cognitive tasks. The energy expenditure was increased in males during cognitive tasks following MVM across day 1 and

day 28. However, in females, mental tiredness was lower; increases in physical tiredness following 30 min of exercise were attenuated; and stress ratings following cognitive tasks were reduced. In males, MVM only lowered mental tiredness following 10 min of exercise. Ferritin levels were also higher after 4 weeks of supplementation (Dodd, et al., 2020).

When quantifying its recovery benefits, 82% of HCPs attributed a contribution greater than 50% to MVMS. Furthermore, 94.4% recognized its positive impact on boosting immunity and significantly reducing the frequency of illness, suggesting its role in improving productivity and quality of life. Practitioners recognized the potential of MVMS to accelerate recovery, enhance energy, and improve immunity, offering tangible benefits in improving patients' quality of life and daily functioning. The high level of agreement across these domains highlights the importance of micronutrient supplementation in clinical practice.

While healthy older adult males show lower incidence of micronutrient deficiencies, the use of MVMS can improve or prevent declines in the status of several vitamins and may prevent declines in cellular bioenergetic status. Although MVMS is regarded as a “one-size-fits-all” strategy and does not target specific micronutrient needs, it is a cost-effective approach to improve micronutrient status in older men as well as significantly reduce missed work days and absenteeism and improve productivity (Lanhart, et al., 2020) These micronutrients are essential for the immune system as they play a role in reducing the frequency and duration of upper respiratory symptoms and may also have an unrecognized or unappreciated impact on maintaining metabolic function in cells (Michels, et al., 2023, Lanhart, et al., 2020). Wei et al., showed that copper was associated with reduced risk of LRTI, vitamin B6 and folate was associated with a lower risk of pneumonia (Wei, et al., 2024),

The result of our survey showed similar outcomes, wherein 98% of experts agreed that MVMS, when taken for a period of 2-3 weeks, leads to a reduction in fatigue levels and promotes a feeling of increased energy throughout the day, leading to faster recovery from acute illnesses, highlighting the potential in supporting the immune system and overall recovery. These findings emphasize the dual role of MVMS in supporting both mental and physical well-being. By improving mental alertness and stamina, the supplement addresses key aspects of daily functioning and quality of life. These benefits make it an important consideration in holistic patient care, particularly for those experiencing mental fatigue, stress, or reduced physical endurance.

The combined total of positive responses to 87.6% highlights a notable belief among HCPs in the potential mental health benefits of multivitamin and mineral supplementation. Specifically, practitioners recognize that MVMS may enhance mental alertness and alleviate stress, highlighting the significance of micronutrients, particularly the vitamin B complex, in promoting cognitive function and emotional well-being, reflecting a strong validation of the impact of balanced micronutrient intake. This strong belief highlights the recognized importance of micronutrients, particularly the vitamin B complex, in promoting cognitive function and emotional stability. Docherty *et al.* investigated the effectiveness of a 12-week MVM supplementation in older adults on measures of wellbeing, mood, memory; physical health and activity; and social interaction and loneliness. The study provided novel evidence of increased friendliness and decreased stress reactivity and loneliness following MVM supplementation over a 12-week period supporting the exploration of broader functions relevant to the aspects of daily living in older adults (Docherty, et al., 2024).

Magnesium is one micronutrient commonly under-consumed (Passarelli, et al., 2024, low levels of magnesium intake have been associated with depression (Rajasekar, et al., 2024, Barbagallo, et al., 2021). A 2024 cross-sectional study using data from the National Health and Nutrition Examination Survey 2017-2020 (n=9,232 adults) found that lower intake of vitamin B6 and magnesium correlated with elevated depressive symptoms (Rajasekar, et al., 2024).

A 2024 systematic review found that five out of the seven studies included in the analysis reported improvements in self-reported anxiety among pediatric and adult patients after magnesium supplementation (Rawji, et al., 2024). A 2018 RCT found that intake of magnesium and vitamin B6 alleviated stress symptoms in men and women (Pouteau, et al., 2018).

A 2019 systematic review and meta-analysis of 18 research articles suggested that supplementation with B vitamin benefited both at-risk (poor nutrient and mood status) and healthy populations specific to improving their reported stress symptoms and overall mood (Young, et al., 2019).

Clinical studies have demonstrated the potential benefits of MVMS in enhancing recovery and improving overall health. A study investigated the impact of multivitamins and multiminerals supplementation in individuals with micronutrient deficiencies and found improvements in fatigue levels and general well-being. Such supplementation may accelerate recovery time in patients, particularly those with deficiencies in key micronutrients, potentially aiding them in resuming normal activities within a period of 2 to 4 weeks (Fantacone, et al., 2020; Ghazzawi, et al., 2023).

The survey responses from this study revealed that 94.4% of HCPs believe that daily consumption of MVMS helps patients return to their normal routines faster, typically within 2–3 weeks. This reflected a strong endorsement of the role of MVMS in expediting recovery and restoring well-being post-illness. These responses suggest that HCPs trust MVMS as an effective supplement for improving recovery from illnesses.

A meta-analysis by Abioye *et al*. reviewed the effects of vitamin D, vitamin C, zinc and multiple micronutrient supplementation (MMS) on the occurrence of acute respiratory infections (ARIs) and the duration of ARI symptoms. The study revealed that supplementation with vitamin C and D and multiple micronutrients reduced the risk of ARI and shortened the duration of symptoms. Zinc did not reduce the risk of ARI, but shortened the duration of symptoms (Abioye, et al., 2021). Barringer *et al*. examined the effect of daily MVMS on infection rates and well-being among adults, with a focus on those aged 45 to 64 years and 65 years or older, including participants with type 2 diabetes mellitus. Over the course of a year, participants who received MVMS reported significantly fewer instances of infection (43% vs. 73%) and lower infection-related absenteeism (21% vs. 57%) compared to those taking a placebo. Notably, participants with type 2 diabetes mellitus saw a dramatic difference, with 93% of placebo users reporting an infection, compared to just 17% of those taking a supplement (Barringer, et al., 2003). These findings suggest that MVMS could reduce the rate of infection and absenteeism in healthy individuals as well as individuals at a higher risk of micronutrient deficiencies. Our study showed a very high agreement with the results of Barringer *et al*., indicating that a significant majority (94.4%) of HCPs believed that MVMS may play a critical role in enhancing the immune function and reducing the frequency of illnesses, which can subsequently lead to improved productivity and fewer missed workdays.

The high level of agreement among the HCPs on the role and use of MVMS across key attributes such as, efficacy, safety, tolerability and safety, indicates that supplementation with multivitamins and multiminerals are reliable and effective treatment strategy and makes it a preferred choice in both preventive and therapeutic settings.

5. CONCLUSION

Multiple micronutrient deficiencies are common across the globe, with the likelihood increasing with age. A common factor throughout life is the need for an adequate supply of micronutrients, which play vital roles in supporting the immune function as well as overall wellbeing. MVMS is recognized and has emerged as a valuable therapy in modern clinical practice owing to its proven efficacy in addressing micronutrient deficiencies and associated multifaceted impact on patient health and related outcomes. A majority of HCPs recognized a strong correlation between micronutrient deficiencies and increased susceptibility to acute infections, underscoring the pivotal role of MVMS in immune modulation. Owing to the broad-spectrum utility of MVMS in both preventive care as well disease management, they are extensively prescribed for conditions such as general weakness, old age, viral fever, URTIs and LRTIs, dengue, malaria, pneumonia, and gastroenteritis with the goal to achieve better clinical outcomes. In this study HCPs reported consistent benefits of MVMS in enhancing energy levels, reducing fatigue, and accelerating recovery from acute illnesses, with the majority agreeing that MVMS contributes significantly to improved patient health within 2 to 3 weeks of regular use. In addition, the majority of HCPs support the role of MVMS in hastening recovery from

acute illnesses and improving immune resilience, making it an indispensable adjunct in therapeutic management aimed at expediting recuperation.

The study findings also highlighted that, MVMS supplementation showed benefits that extended beyond improving physical health, encompassing mental well-being and long-term maintenance of health, thereby ensuring a holistic approach to well-being. HCPs also observed that daily supplementation with MVMS helped improve mental alertness and mood, and reduced stress, thus showing a positive impact on the cognitive function and emotional stability. The MVMS prescribed by the HCPs is a well-balanced formulation of important micronutrients, comprising 12 essential vitamins, 5 trace elements, 2 minerals, and 1 amino acid, and ensures suitability across a broad demographic, from young adults to the elderly, thus comprehensively addressing the diverse nutritional needs. A safe and well tolerated supplement coupled with its efficacy in improving stamina, productivity, and overall well-being are the most important key attributes of a MVMS which solidifies its position as a preferred choice among the HCPs. A majority of the practitioners in our study agreed that MVMS not only addresses nutritional deficiencies but also confers long-term benefits, may help prevent future health complications and support recovery from acute, chronic, and postoperative conditions. This extensive consensus among the HCPs in this study suggests that, MVMS can be a valuable addition for improving patient outcomes, offering a reliable and an all-rounded solution for enhancing the health and the quality of life across a diverse set of patient groups. In conclusion, the findings suggests that targeted micronutrient supplementation has the potential to faster recovery and is a trusted, effective, versatile and a vital adjunct with promising benefits, in both therapeutic as well as preventive healthcare management. As HCPs look for reliable solutions to address the gaps in micronutrient deficiencies and improve patient outcomes, MVMS can aid in setting a benchmark in delivering comprehensive health benefits.

COMPETING INTERESTS DISCLAIMER:
Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

CONSENT: Author consent was obtained prior to conducting the survey. As no patients were involved, patient consent was not applicable.

ETHICAL APPROVAL: Not Applicable

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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