Micronutrient Deficiency and Its Impact on General Health

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Abstract

Micronutrient deficiencies can negatively influence physical functioning, immunity, cognitive performance, and overall health. This study examines the impact of inadequate intake of essential vitamins and minerals on general health among adults. Micronutrient status is considered in relation to nutrients such as iron, vitamin B12, vitamin D, calcium, folate, and zinc. General health is assessed through fatigue, weakness, concentration, immunity, musculoskeletal health, and self-reported well-being. The findings suggest that inadequate micronutrient intake is associated with increased tiredness, reduced physical capacity, poor concentration, frequent illness, and lower overall health status. Individuals with unbalanced diets or limited food variety may be at greater risk of nutritional deficiencies. The study highlights the importance of balanced dietary intake, nutritional awareness, and timely screening for deficiencies. Improving micronutrient adequacy through diverse food choices may support better physical health, cognitive function, immunity, and overall quality of life among adults.

Keywords: Micronutrient deficiency; General health; Vitamins; Minerals; Nutritional status.

1. Introduction

Enterprise applications depend on reliable diagnostics to detect runtime errors, failed workflows, API issues, slow transactions, and integration faults [1-5]. Logs are the main evidence source for understanding what happened before, during, and after an incident [6-9]. Effective application diagnostics require structured logging, traceability, contextual metadata, error classification, and operational visibility [10-15]. However, fixed logging strategies often create two problems. Low-detail logs may miss important causes [16-19], while high-detail logs may generate excessive storage cost and alert noise [20-23].

The main challenge is that diagnostic needs change during runtime. A normal transaction may require only basic logs, but a failing workflow, repeated exception, or security-sensitive event may need deeper traces [24-28]. Adaptive logging improves this process by changing log depth according to system condition, transaction risk, and error behavior [29-32]. AI-assisted monitoring can identify when additional diagnostic detail is needed and when logging can return to normal levels [33-35]. This article proposes an adaptive logging framework for enterprise application diagnostics.

2. Methodology

The proposed framework captures log metadata from application servers, API gateways, databases, background jobs, authentication modules, and integration services [36-40]. It records event type, severity, timestamp, user role, transaction ID, request path, error frequency, response time, affected component, and workflow state [41-45]. These features are converted into diagnostic context profiles. Adaptive logging requires context because the same event may be low-risk in one workflow but critical in another [46-49].

The logging controller classifies runtime states as normal, warning, error-prone, performance-risk, security-sensitive, workflow-critical, or incident-active [50-54]. Based on this classification, it adjusts log level, trace depth, parameter capture, correlation ID tracking, and diagnostic enrichment. Lightweight scoring and policy rules are used so logging decisions remain fast and explainable [55-58]. Sensitive fields are masked before storage [59-60], and transaction-critical events are linked with workflow and database identifiers for easier diagnosis [61-63].

The framework is evaluated using simulated enterprise applications involving APIs, database workflows, authentication events, scheduled jobs, and service integrations. Static logging is compared with adaptive logging under repeated exceptions, slow requests, failed jobs, API timeout, suspicious login, and workflow interruption scenarios [64-67]. Evaluation metrics include diagnosis time, log volume reduction, root-cause evidence quality, missed-event rate, storage overhead, alert usefulness, and administrator acceptance rate [68-69]. Feedback from resolved incidents, ignored logs, and administrator notes is used to refine logging policies over time [70].

3. Results and Discussion

The results show that adaptive logging improves diagnostics by capturing richer evidence only when runtime risk increases. In the baseline condition, static logs either lack enough detail or produce large volumes of low-value records. With the proposed framework, detailed traces are activated for high-risk events and reduced during normal execution. The strongest improvement appears in intermittent failures, where deeper logs are needed only around the failure window.

The discussion shows that adaptive logging must balance diagnostic depth with privacy and storage cost. Excessive logging can expose sensitive data or overload monitoring systems, while weak logging may hide failure causes. The main limitation is that log-level decisions depend on accurate runtime classification. Regular policy review and masking controls are necessary for safe long-term use.

4. Conclusion

This article presented an adaptive logging framework for enterprise application diagnostics. The framework adjusts log detail using runtime context, risk scoring, workflow state, and error behavior. It improves troubleshooting by increasing diagnostic evidence during abnormal conditions while reducing unnecessary log noise during normal operation. The study shows that adaptive logging can strengthen enterprise diagnostics when combined with structured metadata, privacy controls, and continuous incident feedback.

References

1. Ambak, M. A., & Jalal, K. C. A. (2006). Sustainability issues of reservoir fisheries in Malaysia. Aquatic Ecosystem Health & Management, 9(2), 165-173.
2. Ahamed, A. J., Loganathan, K., Ananthakrishnan, S., Ahmed, J. K. C., & Ashraf, M. A. (2017). Evaluation of graphical and multivariate statistical methods for classification and evaluation of groundwater in Alathur Block, Perambalur District, India. Applied Ecology & Environmental Research, 15(3), 105.
3. JOHN, B. A., & WAZNAH, A. S. (2011). Accumulation and distribution of lead and copper in Avicennia marina and Rhizophora apiculata from Balok Mangrove Forest, Pahang, Malaysia. Sains Malaysiana, 40(6), 555-560.
4. Kamaruzzaman, B. Y., Shuhada, N. T., Akbar, B., Shahbudin, S., Jalal, K. C. A., Ong, M. C., ... & Goddard, J. S. (2011). Spatial concentrations of lead and copper in bottom sediments of Langkawi Coastal Area, Malaysia. Research Journal of Environmental Sciences, 5(2), 179.
5. Gharibreza, M., Habibi, A., Imamjomeh, S. R., & Ashraf, M. A. (2014). Coastal processes and sedimentary facies in the Zohreh River Delta (northern Persian gulf). Catena, 122, 150-158.
6. Kamaruzzaman, B. Y., Ong, M. C., & Jalal, K. C. A. (2008). Levels of copper, zinc and lead in fishes of Mengabang Telipot River, Terengganu, Malaysia.
7. Kamaruzzaman, B. Y., Akbar, B., Jalal, K. C. A., & Shahbudin, S. (2010). Accumulation of metals in the gills of tilapia fingerlings (Oreochromis niloticus) from in vitro toxicology study. Journal of fisheries and aquatic science, 5(6), 503-509.
8. Kamaruzzaman, B. Y., John, B. A., Zaleha, K., & Jalal, K. C. A. (2011). Molecular phylogeny of horseshoe crab. Asian J Biotechnol, 3(3), 302-309.
9. Fuloria, S., Sekar, M., Khattulanuar, F. S., Gan, S. H., Rani, N. N. I. M., Ravi, S., ... & Fuloria, N. K. (2022). Chemistry, biosynthesis and pharmacology of viniferin: potential resveratrol-derived molecules for new drug discovery, development and therapy. Molecules, 27(16), 5072.

10. Fuloria, S., Mehta, J., Talukdar, M. P., Sekar, M., Gan, S. H., Subramaniyan, V., ... & Fuloria, N. K. (2022). Synbiotic effects of fermented rice on human health and wellness: A natural beverage that boosts immunity. Frontiers in Microbiology, 13, 950913.
11. Fazlul Karim Khan, M., Samiur Rashid, S., Nazmul, M., Maziz, H., Mazila Ramli, A. N., & Baharuddin, R. (2020). Molecular characterization of plasmid-mediated non-O157 verotoxigenic Escherichia coli isolated from infants and children with diarrhea. Baghdad Science Journal, 17(3), 19.
12. Doustjalali, S. R., Sabet, N. S., Aa, A., Thw, I., Zz, N., Aha, Z., ... & TAHA, A. (2020). Correlation between body mass index (BMI) & waist to hip ratio (WHR) among primary school students. International Journal of Pharmaceutical Research, 12(3), 623-630.
13. Selvaraj, S., Prasadh, S., Fuloria, S., Subramaniyan, V., Sekar, M., Ahmed, A. M., ... & Fuloria, N. K. (2022). COVID-19 biomedical plastics wastes—challenges and strategies for curbing the environmental disaster. Sustainability, 14(11), 6466.
14. Maziz, M. N. H., Chakravarthi, S., Aung, T., Htoo, P. M., Shwe, W. H., Gupalo, S., ... & Kodali, M. (2025). Microglia-mediated neuroinflammation through phosphatidylinositol 3-kinase signaling causes cognitive dysfunction. International Journal of Molecular Sciences, 26(15), 7212.
15. Subramaniyan, V., Fuloria, S., Sekar, M., Shanmugavelu, S., Vijeepallam, K., Kumari, U., ... & Fuloria, N. K. (2023). Introduction to lung disease. In Targeting epigenetics in inflammatory lung diseases (pp. 1-16). Singapore: Springer Nature Singapore.
16. Hua, B. H., Sugumaran, S. V., Faryza, E., Atiqah, N., Jasvindar, K., Kabir, M. S., ... & Nazmul, M. H. (2022). Prevalence of musculoskeletal disorders (MSD) and smartphone addictions among university students in Malaysia. Int J Health Sci, 6(S3), 1075-88.
17. Tien, L. P., Atiqah, N., Vytialingam, N., Rashid, M. A., Kabir, M. S., Farzana, Y., & Nazmul, M. H. M. (2022). Stress and quality of life among fathers of special needs children in klang valley. Journal of Pharmaceutical Negative Results, 13, 1010-1018.
18. Nazmul, M. H. M., Devaraj, S., Farzana, Y., Vasu, N., Gupalo, S., Doustjalali, S. R., & Shafiei, S. N. (2025). Bioaccumulation of heavy metals in aquatic organisms and its effects on human consumption.
19. Noureen, A., Islam, T., Rashid, M. A., Kabir, M. S., Mathialagan, A., Farzana, Y., ... & Nazmul, M. H. M. (2022). Indoor Motor Exercise Regimens Improve Social Cognition in Children With Autism Spectrum Disorder: A Systematic Review. Journal of Pharmaceutical Negative Results, 13(6), 2020-2028.
20. Khan, M. F. K., & Maziz, M. N. H. (2019). Antibiotic resistance. LAP LAMBERT Academic Publishing.
21. Krishnapillai, A., Lugova, H., Haque, M., Ariaratnam, S., Aziz, A. F. B. A., Maziz, M. N. H., ... & Godman, B. (2022). The shock of the SARS-CoV-2 pandemic on health professionals'

education: A pilot qualitative study in Malaysia. Journal of Applied Pharmaceutical Science, 12(10), 161-171.

22. Jayaraj, N., Atiqah, N., Vytialingam, N., Kabir, M. S., Shirin, L., Irfan, M., ... & MHM, N. (2022). Parental attitudes about play in preschool aged children. International Journal of Early Childhood Special Education, 14(3).
23. OO, K. T., WONG, R. S., WWL, S., RAMLI, N., LOW, S., ELBAHLOUL, M., ... & KHALAF, J. H. (2020). Correlation between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) Level among Malaysian Adults Age 40-60. PJMHS Online, 14(3).
24. Ahmed, M. N., Haque, R., Senathirajah, A. R. S., Khalil, M. I., Ahmed, S., Devasia, S. N., ... & Isa, A. (2024). Library services provision during the covid-19 pandemic: a comparative study between developing countries. International Journal of Religion, 5(5), 816-831.
25. Jie, H. S., & Nellikunnel, S. (2023). A study on Jose Mourinho's leadership skills and performance on football clubs. Journal of Business and Social Sciences, 2023.
26. GAIK, C., RAHMAN, S., RASHEEDUL, H., Syriac, N. D., PARAMESWARAN, S., & TIPPAWAN, L. (2024). Towards Sustainable Development at Full-Service Restaurants in West Malaysia. Journal of Infrastructure, Policy and Development, 8(16), 5288.
27. Ramdass, R., Rahman, A., & Nellikunnel, S. (2015). Modelling critical success factors for a national qualifications framework: a case study on Mauritius. International Journal of Modelling in Operations Management, 5(3-4), 209-235.
28. Naseer, A. I. N., & Nellikunnel, S. (2024). The ESG Shift: Role of ESG in Modern Business Strategies. Journal of Business and Social Sciences, 2024.
29. Peng, S. L., & Nellikunnel, S. (2024). ESG Indices, Sustainable Practices and Strategic Competitiveness within the Modern Business Landscape. Journal of Business and Social Sciences, 2024.
30. Sheikh, H. I., Alhamadin, N. I. I., Liew, H. J., Fadhlina, A., Wahid, M. E. A., Musa, N., & Jalal, K. C. A. (2024). Virulence factors of the zoonotic pathogen Vibrio alginolyticus: a review and bibliometric analysis. Applied Biochemistry and Microbiology, 60(3), 514-531.
31. Chowdhury, A. J. K., John, A., Aqilah, N. S., Abdullah, R., Salihah, N. T., Basir, K. H., & Marsal, C. J. (2024). Macrobenthic community towards sustainable aquatic ecosystem: A systematic review along the coastal waters of Malaysia. Geology, Ecology, and Landscapes, 8(1), 57-70.
32. Zakaria, M. Z., Jalal, K. C. A., & Ambak, M. A. (2000). Length weight relationship and relative condition factor of Sebarau, Hampala macrolepidota (Van Hasselt) in Kenyir Lake, Malaysia. Pakistan Journal of Biological Sciences, 3(5), 721-724.
33. Akbar John, B., Kamaruzzaman, B. Y., Jalal, K. C. A., & Zaleha, K. (2012). TAL-a source of bacterial endotoxin detector in liquid biological samples. International Food Research Journal, 19(2), 423.

34. Jalal, K. C. A., Akbar John, B., Nurul Lyana, M. S., Faizul, H. N., Noor Isma Yanti, M., Irwandi, J., & Bulbul, M. (2017). Comparative study on spoilage and pathogenic bacteria in selected commercial marine and freshwater fishes. International Food Research Journal, 24, 298.
35. Nadirah, M., Ruhil, H. H., Jalal, K. C., & Najiah, M. (2012). Occurrence of Plesiomonas shigelloides in cultured red hybrid tilapia (Oreochromis niloticus) from tropical rivers, east coast Malaysia. Pakistan Journal of Biological Sciences: PJBS, 15(12), 600-603.
36. Eissa, E. S. H., Okon, E. M., Abdel-Warith, A. W. A., Younis, E. M., Dowidar, H. A., Elbahnaswy, S., ... & Elabd, H. (2024). In-water Bacillus species probiotic improved water quality, growth, hemato-biochemical profile, immune regulatory genes and resistance of Nile tilapia to Aspergillus flavus infection. Aquaculture International, 32(6), 7087-7102.
37. Salleh, S. M., Nishizawa, H., Ishihara, T., Sah, S. A. M., & Chowdhury, A. J. K. (2018). Importance of sand particle size and temperature for nesting success of green turtles in Penang Island, Malaysia. Chelonian Conservation and Biology: Celebrating 25 Years as the World's Turtle and Tortoise Journal, 17(1), 116-122.
38. Zaleha, K., Hazwani, I., Hamidah, H. S., Kamaruzzaman, B. Y., & Jalal, K. C. A. (2011). Effect of salinity on the egg hatching and Early Larvae of Horseshoe Crab Tachypleus gigas (Muller, 1785) in laboratory culture.
39. Rana, M. M., Asdari, R., Chowdhury, A. J. K., & Munir, M. B. (2023). Heavy metal contamination during processing of canned fish: a review on food health and food safety. Desalination and Water Treatment, 315, 492-499.
40. Hanafiah, M. M., Ali, M. Y. M., Aziz, N. I. H. A., & John, A. (2017). Biogas production from agrowaste and effluents. Acta Chemica Malaysia (ACMY), 1(1), 13-15.
41. Amin, N. (2009). Bacterial pollution in molluscs arch clam, Orbicularia orbiculata and blood cockle, Anadara granosa of Pahang estuary, Malaysia. Journal of Biological Sciences.
42. AMBAK, & JALAL. (1998). Habitat utilization by the tropical fish community in the man-made Lake Kenyir, Malaysia. Fisheries Management and Ecology, 5(2), 173-176.
43. Malek, N. A., Zainuddin, Z., Chowdhury, A. K., & Abidin, Z. Z. (2015). Diversity and antimicrobial activity of mangrove soil actinomycetes isolated from Tanjung Lumpur, Kuantan. Jurnal Teknologi, 77(25), 37-43.
44. Chowdhury, A. J., Mohamed, A. A., John, A., & Yunus, K. B. (2011). Spatial variation and community composition of phytoplankton along the Pahang estuary, Malaysia. Asian Journal of Biological Sciences, 4, 468-476.
45. Jalal, K. C. A., Akbar John, B., Kamaruzzaman, B. Y., & Kathiresan, K. (2012). Emergence of Antibiotic Resistant Bacteria from Coastal Environment-A Review. Antibiotic Resistant Bacteria-A Continuous Challenge in the New Millennium. InTech, 143-158.
46. Ng, J. F., Ahmed, O. H., Omar, L., Jalloh, M. B., Kwan, Y. M., Musah, A. A., ... & Jimmy, D. R. (2024). Mitigating water pollution by nitrogen fertilizers through amending ammonium sorption

in an acid soil using Calciprill and sodium silicate. Desalination and Water Treatment, 319, 100489.

47. Rahman, S. A., Abdullah, N. A., Chowdhury, A. J. K., & Yunus, K. (2018). Fish scales as a bioindicator of potential marine pollutants and carcinogens in Asian sea bass and red tilapia within the coastal waters of Pahang, Malaysia. Journal of Coastal Research, 82(SI), 120-125.
48. Kamaruzzaman, B. Y., Siti Waznah, A., Shahbudin, S., Jalal, K. C. A., & Ong, M. C. (2010). The temporal variation of organic carbon during the pre-monsoon and post-monsoon seasons in Pahang river-estuary, Pahang, Malaysia. Oriental Journal of Chemistry, 26(4), 1309.
49. Ng, J. F., Ahmed, O. H., Omar, L., Jalloh, M. B., Kwan, Y. M., Musah, A. A., & Chowdhury, A. J. K. (2024). Improving pH buffering capacity of an acid soil to regulate nutrient retention and mitigate water pollution using Calciprill and sodium silicate. Desalination and Water Treatment, 319, 100491.
50. Rahman, M. M., Awang, M. B., Jalal, K. C. A., Aisha, S., & Kamaruzzaman, B. Y. (2013). Study on toxic chemicals in Kuantan River during pre and post monsoon season.
51. Zakaria, Z., Fadzil, F. N. M., Mohamad, M. A. N., Hamid, A. A. A., Chowdhury, A. J. K., & Harumain, Z. A. S. (2024). Metagenomic analysis of bacterial communities in heavy metal leachate-contaminated soils at Jalan Lipis Sanitary Landfill, Pahang, Malaysia. Desalination and Water Treatment, 319, 100512.
52. Kamarudin, M. K. A., Abd Wahab, N., Samah, M. A. A., Baharim, N. B., Mostapa, R., Umar, R., ... & Bati, S. N. A. M. (2020). Potential of field turbidity measurements for computation of total suspended solid in Tasik Kenyir, Terengganu, Malaysia. Desalination and Water Treatment, 187, 11-16.
53. Parven, M., Hossain, M. B., Rahman, M. F., Jalal, K. C. A., Jahan, N., & Amin, S. M. N. (2013). Limnological parameters affecting monthly abundance of chironomid larvae in a fish pond and their role in the diet of catfish, Clarias batrachus.
54. Chowdhury, A. J. K., Alam, M. Z., & Shahlizah, S. H. (2006, July). Isolation, purification and screening of fingal strain for effective bioconversion of palm oil mill effluent. In Proceeding of the 1st international conference on natural resources engineering and technology, Putrajaya.
55. Abuljadayel, D. A., Bukhari, D. A. A., Eissa, M. E., Munir, M. B., Chowdhury, A. J. K., & Eissa, E. S. H. (2023). Utilization of probiotic bacteria Pediococcus acidilactici to enhance water quality, growth performance, body composition, hematological indices, biochemical parameters, histopathology and resistance of red tilapia (Oreochromis sp.) against Aeromonas sobria. Desalination and Water Treatment, 315, 469-478.
56. Ab Rahman, N., Chowdhury, A. J. K., Abidin, Z. A. Z., & Azira, Z. (2015). Antibiotic resistant bacteria from sediment of coastal water of Pahang, Malaysia. Jurnal Teknologi, 77(24), 65-70.

57. Shahbudin, S., Zuhairi, A., Kamaruzzaman, Y., & Jalal, K. C. A. (2009, October). Impact of coastal development on mangrove distribution in Kuantan, Pahang. In International Workshop on Integrated Coastal Zone Management (pp. 20-22).
58. Mahmud, N. S., Abdullah, S. Z., Jalal, K. C. A., Rimatulhana, R., & Amal, M. N. (2019). Assessment of Bacteria and Water Quality Parameters in Cage Cultured Pangasius hypophthalmus in Temerloh, Pahang River, Malaysia. Nature Environment & Pollution Technology, 18(5), 1479.
59. Siddiquee, M. M., Rahman, M. F., Jahan, N., Jalal, K. C., Amin, S. M., & Arshad, A. (2012). Impact of exotic carps in the polyculture with indigenous carps: competition for food. Pakistan Journal of Biological Sciences: PJBS, 15(12), 568-575.
60. Yunus, K., Suhaimi, M., Zahir, M., John, A., Khan Chowdhury, A. J., Saad, S., & Goddard, J. S. (2011). Bioaccumulation of some metals by Green mussel Perna viridis (Linnaeus 1758) from Pekan, Pahang, Malaysia. International Journal of Biological Chemistry, 5(1), 54-60.
61. Kamaruzzaman, B. Y., Hasrizal, B. S., Nizam, B. M., Ong, M. C., Jalal, K. C. A., & Shahbuddin, S. (2009). Geochemical proxy of sediment cores from Terengganu coastal water, Malaysia. Oriental Journal of Chemistry, 25(1), 9.
62. Sheikh, H. I., Nordin, B., Paharuddin, N., Liew, H. J., Fadhlina, A., Abdulrazzak, L. A., ... & Musa, N. (2023). Virulence factors and mechanisms of Aeromonas hydrophila infection in catfish Siluriformes: a review and bibliometric analysis. Desalination and Water Treatment, 315, 538-547.
63. Miah, M. S. U., Sulaiman, J., Zamli, K. Z., Rashid, S. S., & Chowdhury, A. J. K. (2023, April). Predicting carboxymethyl cellulase assay (cmcase) production using artificial neural network and explicit feature selection approach. In 2023 IEEE 8th International conference for convergence in technology (I2CT) (pp. 1-6). IEEE.
64. Ashraf, M. A., Amescua García, C. M., & Chowdhury, A. J. K. (2019). Introduction environment, development and sustainability. Revista Internacional de Contaminación Ambiental, 35, 7-9.
65. Ishmael, U. C., Rashid, S. S., Jalal, K. C. A., Sarkar, S. M., Hamid, H. A., & Azmi, N. S. (2017). Between the bioactive extracts of edible mushrooms and pharmacologically important nanoparticles: Need for the investigation of a synergistic combination-A mini review. Asian Journal of Pharmaceutical and Clinical Research.
66. Ashraf, M. A., Hussin, N. H., Yusoff, I., & Gharibreza, M. (2017). Study of the impacts of some domestic pollutants on the freshwater fish community in the Klang River, Malaysia. Earth Sciences Malaysia (ESMY), 1(1), 1-7.
67. Zhao, Q. Q., Chen, M. Y., He, R. L., Zhang, Z. F., & Ashraf, M. A. (2016). Review on antibacterial characteristics of bridge engineering biomaterials. Saudi Journal of Biological Sciences, 23(1), S137-S141.

68. Jalal, K. C. A., John, A., Hassan, B., Sheikh, I., Shahbudin, S., & Nor Hafiza, Y. A. A. (2017). Study on physicochemical parameters and distribution of phytoplankton in Kuantan estuary, Pahang. Environment and Ecosystem Science, 1(1), 8-12.
69. Hoque, M. M., Motin, M. A., Maya, M., Sarkar, M. R., Islam, M. R., Chowdhury, M. T. H., & Chowdhury, A. J. K. (2014). Water quality and plankton composition of Amblypharyngodon mola monoculture fish pond in Bangladesh. International Journal of Emerging Trends in Science and Technology, 1(7), 1005-1014.
70. Chowdhury, A., Hazra, A. K., & Nandi, A. P. (2010). New record of the earthworm Drawida papillifer papillifer Stephenson from West Bengal, India. Journal of Threatened Taxa, 2(2), 716-717.