J Afric Neonatal 2025;3: 130 - 137

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Redeat Workneh Tadesse
Karen Walker
Benenia Muzuva
Adeleye Atinuke Bodunde
Metsihet Merhatsedk Mezgebu
Misreta Badeg
John Baptist Nkuranga
Pamela Henderson
Veronica Moses
Helina Selam
Erika M. Edwards
Alexander G. Stevenson
Danielle E.Y. Ehret
Mahlet Abayneh
Misrak Tadesse

Current staffing landscape in neonatal units in Africa: Insights from the African Neonatal Network

https://dx.doi.org/10.4314/jan.v3i3.10

Received: 1st July 2025
Accepted: 7th July 2025

Redeat Workneh Tadesse, (✉)
Metsihet Merhatsedk Mezgebu,
Mahlet Abayneh
St Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia
Email: redugold@gmail.com

Karen Walker
University of Sydney, Sydney, Australia

Benenia Muzuva
Mbuya Nehanda Maternity Hospital, Harare, Zimbabwe

Adeleye Atinuke Bodunde
Federal Teaching Hospital, Ido Ekiti, Nigeria

Misreta Badeg
Hawassa Comprehensive Referral Hospital, Hawassa, Ethiopia

John Baptist Nkuranga
University of Rwanda/African Health Sciences University, Kigali, Rwanda

Pamela Henderson
Veronica Moses
Alexander G. Stevenson
African Neonatal Network, Kigali, Rwanda and Harare, Zimbabwe

Abstract: *Background:* Despite recommendations, healthcare workforce standards for neonatal units in low- and middle-income countries remain largely undefined.
Methods: Fourteen hospitals in the African Neonatal Network responded to an annual facility survey and a health facility survey co-developed by faculty in the African Neonatal Network and Vermont Oxford Network. All analyses use descriptive statistics.
Result: Most neonatologists/paediatricians (71%) were on call at home some of the time, with 21.4% available on call in the hospital. Most hospitals (71%) considered neonatal nursing a specialty. Nurses typically had specific patient assignments (93%), with nurse-to-patient ratios based on acuity (64%). The median number of full-time equivalent nurses was 16, with an average of 6 nurses on day shifts and 5 on night shifts. Respiratory support varied, with mechanical ventilation used most at nurse-to-patient ratios of 1:1 to 1:4 and 1:1, and 1:3 to 4 ratios (21%), and CPAP most commonly at a 1:3-4 ratio (43%). For stable, growing premature infants weighing over 1500 grams, 5 (36%) hospitals reported ratios of 1:3-4 while eight (57%) hospitals reported ratios of either 1:5-7 or 1:8-10. The median number of patients per nurse was 4 on weekdays, and 5 on nights and weekends.
Conclusion: This study underscores the urgent need for standardized staffing guidelines tailored to the unique contexts of sub-Saharan African neonatal units. Addressing staffing inconsistencies and retention issues is essential to enhance the quality of neonatal care and improve health outcomes. Collaborative efforts are imperative to establish standardized workforce criteria, ultimately promoting better health for newborns.

Keywords: Infant, Newborn; Infant, Premature; Neonatal Intensive Care Units; Health Personnel / standards; Neonatal Nursing / organization & administration; Nurse-Patient Ratio; Workforce; Africa South of the Sahara; Global Health

Résumé: *Contexte:* Malgré les recommandations, les norms en matière de personnel de santé pour les unites néonatales dans les pays à revenue faible et intermédiaire demeurent largement non définies.
Méthodes: Quatorze hôpitaux membres du Réseau Néonatal Africain ont participé à une enquête annuelle sur les structures hospitalières

Helina Selam
Vermont Oxford Network,
Burlington, Vermont, USA

Erika M. Edwards
Danielle E.Y. Ehret
Vermont Oxford Network and
University of Vermont, Burlington,
Vermont, USA

Misrak Tadesse
Vermont Oxford Network and Johns
Hopkins School of Medicine,
Baltimore, Maryland, USA

ainsi qu'à uneenquête sur les établissements de santé, co-développées par des experts du Réseau Néonatal Africain et du Vermont Oxford Network. Toutes les analyses ont été réalisées à l'aide de statistiques descriptives.
Résultats: La majorité des néonatologistes/pédiatres (71%) étaient d'astreinte à domicile à certains moments, tandis que 21,4% étaient d'astreinte à l'hôpital. La majorité des hôpitaux (71%) considéraient les soins infirmiers neonatal comme une spécialité. Les infirmier· ère·s avaient généralement des affectations précises de patients (93%), avec des ratios infirmier/ patient adaptés à la gravité des cas (64%). Le nombre median d'équivalents temps plein infirmiers était de 16, avec une moyenne de 6 infirmier·ère·s de jour et 5 de nuit. Le recours à l'assistance respiratoire variait : la ventilation mécanique étaitut ilisée principalement avec des ratios infirmier/ patient allant de 1:1 à 1:4 (21%), tandis que la CPAP était le plus souventutilisée avec un ratio de 1:3-4 (43%). Pour les nouveau-nés prématurés stables et encroissance pesant plus de 1500 grammes, 5 hôpitaux (36%) rapportaient un ratio de 1:3-4, tandis que 8 hôpitaux (57 %) déclaraient des ratios de 1:5-7 ou de 1:8-10. Le nombre médian de patients par infirmier·ère était de 4 en semaine et de 5 durant les nuits et les week-ends.
Conclusion: Cette étude met en evidence l'urgence d'élaborer des lignes directrices normalisées en matière de dotation en personnel, adaptées aux contexts spécifiques des unites néonatales en Afrique subsaharienne. La résolution des disparités de dotation et des défisliés à la rétention du personnel estessentielle pour améliorer la qualité des soins néonatals et les resultants cliniques. Des efforts collaboratifs sont indispensables pour établir des critères de resources humaines harmonisés, dans le but de promouvoir une meilleure santé néonatale.

Introduction

Since 1990, significant advancements have been made globally in child survival, particularly concerning neonatal mortality. The global number of neonatal deaths has decreased from 5.0 million in 1990 to 2.3 million in 2022, a notable improvement. However, sub-Saharan Africa continues to be a critical area of concern, accounting for 57% of total under-five deaths approximately 2.8 million despite representing only 30% of worldwide live births. The region also experiences the highest neonatal mortality rate globally, with 27 deaths per 1,000 live births.[1]

The stark disparities in neonatal survival underscore the impact of geographic location on children's chances of survival. In sub-Saharan Africa, the risk of a newborn dying within the first month of life is nearly eleven times higher than in regions with the lowest mortality rates, such as Australia and New Zealand.[2] In 2022, neonatal mortality rates (NMRs) in various countries ranged from just 0.7 to a staggering 39.4 deaths per 1,000 live births, illustrating significant inequities in health outcomes.[1]

To address and mitigate neonatal mortality, the World Health Organization (WHO) recommends that countries establish a solid foundation of essential newborn care in line with Every Newborn Action Plan (ENAP) and the Ending Preventable Maternal Mortality (EPMM) targets. This recommendation includes the expansion of level 2 special care units and implementing human resource strategies to optimize newborn care in low- and middle-income countries (LMICs). These strategies should focus on effective staffing practices, appropriate staff ratios, and skill mixes in level 2 newborn units, as well as the enhancement of antenatal and postnatal care and access to emergency obstetric and newborn care.[3] Specifically, meeting the needs of small and sick newborns and providing emergency obstetric care are paramount, high-impact interventions.

While there has been progress in increasing facility-based deliveries in sub-Saharan Africa since 2000, only about 60% of births currently occur in health facilities, with significant variances across countries ranging from 41.0% in Nigeria to 93.8% in Rwanda.[4] These statistics forecast an increasing staffing demand as the proportion of deliveries occurring in health facilities attended by skilled providers increases globally. Although the increase in facility-based deliveries has been encouraging, improvements in the quality of service have not kept pace with the increase in facility births.

As emphasized by the WHO Health Systems Framework, a competent healthcare workforce is essential for achieving better health outcomes.[5] The critical importance of appropriately staffing neonatal units—ensuring the right mix of healthcare providers in adequate numbers cannot be overstated. In high-income countries

established staffing recommendations, including patient-to-health worker ratios, are well-defined by prominent professional organizations, such as the American Academy of Pediatrics, the American College of Obstetrics and Gynaecology, the National Association of Neonatal Nurses, and the Association of Women's Health, Obstetric, and Neonatal Nursing, along with guidance from the National Quality Board of the National Health System in England.[6,7,8] In stark contrast, LMICs frequently lack established staffing norms. Besides the WHO's strategy on human resources generalized guidance on the composition of specialized teams for level 2 units and the expert consensus reports from Kenya, illustrative staffing ratios derived from data from South Africa, and Indian special care nursery units, no standardized staffing ratios exist for neonatal units in LMICs.[9,10] This absence hinders our understanding of the current landscape and complicates resource allocation.

To effectively address workforce needs, it is imperative to analyse the staffing situation in neonatal units across sub-Saharan Africa. This study aims to assess staffing conditions in neonatal units across fourteen African Neonatal Network (ANN) member hospitals in five sub-Saharan African countries, shedding light on the current practices and pinpointing areas requiring attention to enhance neonatal care.

Methods

Data collection was conducted in 14 ANN member hospitals across five countries: Ethiopia, Nigeria, Rwanda, Uganda, and Zimbabwe.

Vermont Oxford Network (VON) conducts an annual survey for members that was co-developed with ANN faculty members, which includes information on the hospital setting, number of beds and admissions, staffing, obstetric service, follow-up clinic, resuscitation and essential newborn care, transfers and transport, family-centred care, services provided by the neonatal unit, guidelines in the neonatal unit, quality assurance/ continuous quality improvement, and level of neonatal care. Participation in the membership survey is mandatory. The responses used for this manuscript are from 2023.

In October 2023, the ANN conducted a health facility assessment to collect more detailed information on buildings and facilities, medications, diagnostics and consumables, equipment, staffing, governance, thermal regulation and foetal transition, nutrition, family-centred care and kangaroo mother care, infection prevention and control, and perceived priorities.

Tables of hospital-level measures include data from both the membership survey and the health facility assessment. All analyses are descriptive.

The collaborative QI project and subsequent assessments received individual and hospital institutional research and ethics review approvals at the start of the collaborative and learning initiative.

Results

Staffing

Of the 14 hospitals, three (21%) reported that neonatologists or paediatricians were available on call in the hospital at all times while 10 (71%) reported that neonatologists/paediatricians (71%) were on call at home some of the time and one hospital (3%) did not have neonatologist/paediatrician coverage 24 hours per day. In eight hospitals, house staff participated in direct patient care and provided in-hospital coverage 24 hours per day. Nurses were generally assigned specific patients during shifts (93%), and the nurse-to-patient ratio depended on acuity (64%). Only 21% of NICUs had respiratory therapy available.

As seen in Figure 1, the coverage of paediatric subspecialties exceeded 50% for ophthalmology (71%), cardiology (57%), orthopaedics (57%), surgery (57%), anaesthesiology (57%), neurosurgery (50%), and neurology (50%). However, paediatric sub-specialty coverage or services were below 50% for physical/occupational therapy (42%), infectious diseases (35%), endocrinology (35%), pulmonology (21%), gastroenterology (21%), audiology (21%), respiratory therapy (21%) and medical genetics (7%).

Length of Time in the Unit

Participating units were asked, on average, the length of time staff members work in their neonatal unit. Half of the facilities reported that neonatologists work in the unit for more than five years, while 36% reported that paediatricians, specialist nurses, and general nurses work in the unit for more than five years (Table 2). However, 36% of units reported that specialist nurses stay less than one year, and 21% of units reported that paediatricians stay less than one year.

Nurse Staffing and Patient Care Ratios in the Neonatal Unit

Table 3 presents the nurse-to-patient ratios for corresponding types of respiratory support provided. Eight hospitals (57%) reported having ratios of 1:1 to 1:3-4 for infants on mechanical ventilation, while six hospitals (43%) reported ratios of 1:2 for infants on CPAP. For stable, growing premature infants weighing over 1500 grams, five (36%) hospitals reported ratios of 1:3-4 while eight hospitals reported ratios of either 1:5-7 or 1:8-10.

The median number of full-time equivalent nurses providing direct patient care in the neonatal unit was 16

(Fig 2). A median of six nurses worked the day shift and 5 worked the night shift. The median number of patients a nurse cared for during a day shift, on average, was 4 (IQR: 3, 5). On the night shift, the median was 5 patients per nurse (IQR: 3, 8). During weekend shifts, the median was 5 patients per nurse (IQR: 3, 10).

Knowledge Sharing

Table 3 describes the frequency of meetings on various topics and for different groups. All hospitals reported meeting at least once a month to review every neonatal death and nine (64%) met every month to review every stillbirth. Eleven of the hospitals (79%) met every month to review data from the neonatal unit. Six of the hospitals reported that senior medical and nursing staff met once a month, while nine (64%) reported meeting with obstetricians and midwives at least once a month.

Table 1: Staffing and availability by profession in neonatal units among 14 African Neonatal Network hospitals

	# (%)
Neonatologist or paediatrician available 24/7	
Yes, on call in hospital at all times	3 (21)
Yes, on call at home some of the time	10 (71)
No	1 (7)
House staff participate in direct patient care	8 (57)
House staff provide 24 hours/day in-hospital coverage	8 (57)
Nursing	
Nurses rotate across maternal newborn child health units	9 (64)
Neonatal nursing is considered a specialty	10 (71)
Nurses assigned to care for specific patients during shifts	13 (93)
Nurse-to-patient ratio depends on acuity	9 (64)
Social worker available to provide support to the NICU	10 (71)
Biomedical engineer available 24/7	11 (79)
Respiratory therapy	3 (21)

Table 2: Length of stay of healthcare providers in neonatal units among 14 African Neonatal Network hospitals

	Review every neonatal death	Review every still birth	Review key data from neonatal ward	Between senior medical and nursing staff	With obstetricians and midwives
	# (%)	# (%)	# (%)	# (%)	# (%)
<1 year	14 (100)	9 (64)	11 (79)	6 (43)	9(63)
1-2 years		1 (7)	2 (14)	6 (43)	1 (7)
3-5 years				1 (7)	
>5 years		3 (21)	1 (7)	1 (7)	3 (21)
NA		1 (7)			1 (7)

Table 3: Nurse: patient ratio for various scenarios in 14 African Neonatal Network hospitals

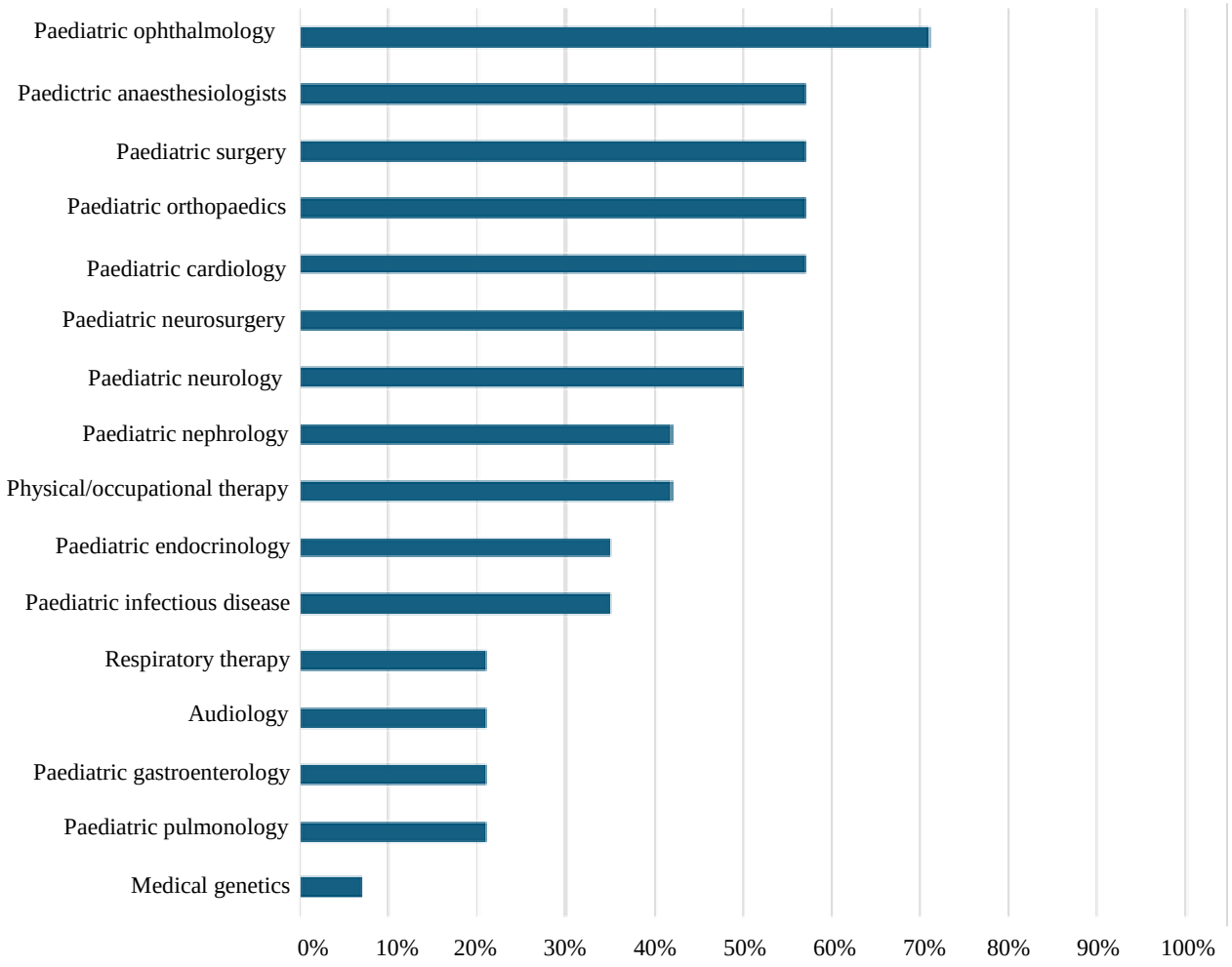
Patient Scenario/ Ratio	1:1	1:2	1:3 to 4	1:5 to 7	1:8 to 10	1:10 to 15
	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)
Mechanical ventilation*	3 (21)	2 (14)	3 (21)	2 (14)		
CPAP		3 (1)	6 (43)	4 (29)	1 (7)	
Stable, growing premature infant >1500 g			5 (36)	4 (29)	4 (29)	1 (7)

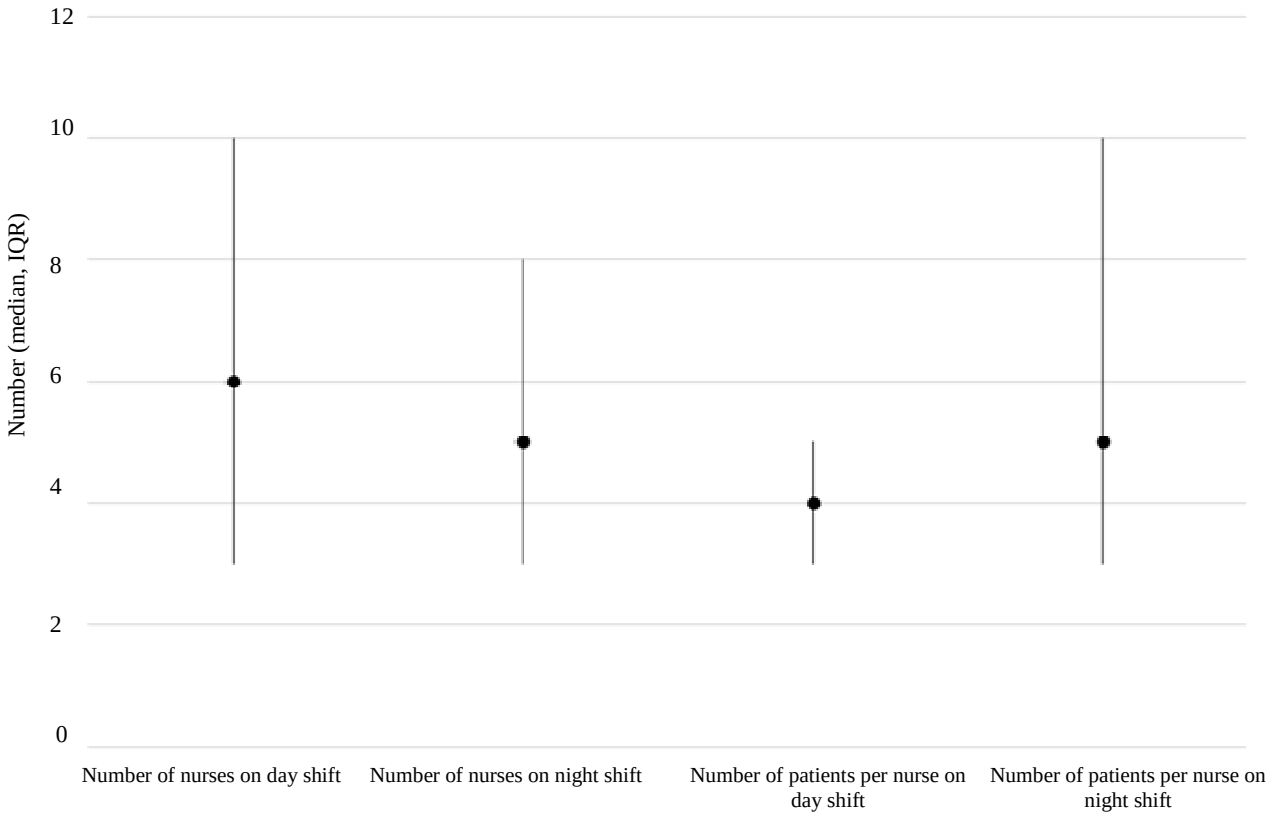
*Four units responded 'not applicable'

Table 4: Frequency of meetings in neonatal units at 14 African Neonatal Network Hospitals

	Review every neonatal death	Review every stillbirth	Review key data from neonatal ward	Between senior medical and nursing staff	With obstetricians and midwives	Between clinicians and management
	# (%)	# (%)	# (%)	# (%)	# (%)	# (%)
At least once a month	14 (100)	9 (64)	11 (79)	6 (43)	9 (63)	9 (64)
At least once a quarter		1 (7)	2 (14)	6 (43)	1 (7)	1 (7)
At least once a year				1 (7)		2 (14)
Never		3 (21)	1 (7)	1 (7)	3 (21)	2 (14)
Unknown		1 (7)			1 (7)	

Fig 1: Availability of paediatric sub-specialties and health care support among African Neonatal Network hospitals (%)





Discussion

This study aimed to provide an assessment of staffing in neonatal care at 14 hospitals in 5 African countries. Despite the WHO recommendations regarding human resource strategies aimed at improving newborn care, there remains a significant lack of specific healthcare workforce standards for neonatal units in LMICs. WHO and UNICEF advise that neonatal care units in these regions adopt staffing models that ensure adequate coverage for all critical tasks.[11,12] However, our study highlights how staffing standards remain unstandardized, revealing considerable variations both in the composition and ratios of staff across the fourteen hospitals surveyed.

Neonatologists play a pivotal role in enhancing neonatal care, yet many LMICs struggle to staff full-time specialists. Our survey indicates that 92% of hospitals reported on-call availability of neonatologists or paediatricians around the clock, in line with WHO recommendations for secondary and tertiary level newborn units. Moreover, 57% of doctors were always present in the hospital to attend to emergencies, which is crucial given the scarcity of neonatologists. In their absence, general physicians contribute significantly to the management of neonatal units, even without specialized training in neonatology.[13,14]

Adequate staffing is critical for ensuring safe and effective care for patients in neonatal care units, who are vulnerable infants entirely reliant on their caregivers. A sufficient quantity and appropriate mix of qualified nurses are essential in neonatal units.[15] Notably, nearly all (93%) ANN hospitals reported that nurses are assigned to care for specific patients during their shifts. These findings indicate significant progress in nursing coverage, aligning with best practices that recommend a dedicated nurse for each patient.

WHO estimates a global shortage of over 5.9 million nurses, with 89% of this need concentrated in LMICs. This deficit often results in general nurses with limited specialized training filling neonatal roles, hindering the advancement of neonatal nursing as a recognized formal specialty in these regions.[11] In many LMICs, neonatal nursing lacks the formal recognition it enjoys in high-income countries. However, in 10 out of the 14 ANN facilities (71%), neonatal nursing is acknowledged as a specialty. This finding is encouraging, as ongoing efforts in education, training, and global health support may lead to the formalization and increased recognition of neonatal nursing.[16,17] However, the ANN data reveals that the median percentage of nursing staff identified as neonatal specialty nurses was 13% with wide variation, with the lowest unit reporting no neonatal specialty nurses and the highest reporting 100%. This inconsistency underscores the need for targeted efforts to enhance neonatal nurse specialization[11]

Nurse-to-patient ratios in newborn units vary widely, often influenced by factors such as facility type and available resources. The WHO "Guidelines for Newborn Care in LMICs"[3] recommend staffing ratios of 1 nurse for every 2-3 critically ill infants in neonatal care units and 1 nurse for every 5-10 newborns in low-risk units that provide basic care and monitoring. In the participating ANN units, nurses cared for a median of 4 patients on weekdays and 5 patients on nights and weekends. A study conducted in Kenya found that private sector facilities reported a median ratio of 3 babies per nurse, with a maximum of 7, while public sector facilities indicated a median of 19 babies per nurse, with some instances exceeding 25 per nurse.[18] In contrast, high-income countries typically adhere to stricter staffing standards. For instance, the European Standards of Care recommend a 1:1 nurse-to-infant ratio for intensive care, 1:2 for intermediate care, and 1:4 for special care. Such ratios are associated with improved neonatal outcomes, emphasizing the critical role of adequate staffing in neonatal care.[9,19]

In the current study, 21% of hospitals reported that patients on mechanical ventilation would have a 1:1 nurse-to-patient ratio, while 14% reported a 1:2 ratio. For newborns on CPAP, 43% of hospitals reported a 1:3 to 1:4 ratio. Additionally, 36% of hospitals reported that stable and growing premature infants weighing more than 1500 grams would have a 1:3 to 1:4 ratio, with the remaining hospitals reporting higher ratios. Although lower ratios (1:1 and 1:2) are preferable for intensive care settings, higher ratios (1:5 to 1:7) may indicate resource constraints that could adversely affect the quality of care. This data underscores the need for appropriate staffing in neonatal units, especially in critical areas such as mechanical ventilation, where close monitoring is vital for patient survival and recovery. Addressing the challenges posed by low nurse-to-patient ratios in LMICs necessitates targeted human resource strategies. The WHO advocates for policies ensuring sufficient and well-trained nursing staff to enhance the quality of newborn care. Implementing evidence-based staffing policies informed by local data is essential for improving neonatal care in resource-constrained environments.[11]

Support staff are crucial for maintaining high-quality neonatal care in resource-limited settings. This category includes respiratory therapists, biomedical engineers and technicians, physiotherapists, social workers, and other healthcare professionals who play an essential role in the effective functioning of NICUs, particularly in areas where resources are scarce and neonatal mortality rates are high.[20-22] Data from ANN hospitals indicate that 79% of hospitals have biomedical engineers, 71% have social workers, and 21% have respiratory therapists on staff, highlighting the need for increased coverage of these essential supportive roles. Given the shortage of specialized neonatal care professionals and existing resource constraints, these supportive staff members help bridge the gap, ensuring that newborns receive the necessary care despite prevailing challenges.[16,17]

Staff turnover and retention in newborn units pose significant challenges that directly influence the quality of neonatal care and the overall effectiveness of healthcare services. Many LMICs face a shortage of skilled healthcare workers, particularly in neonatal specialties, a problem that is exacerbated by high turnover rates.[18,20,21] Research in East and Southern Africa has highlighted alarming nurse turnover rates in neonatal units. For instance, a study in Ethiopia reported an annual turnover rate of 25% among neonatal care nurses, primarily due to salary dissatisfaction, heavy workloads, and limited professional development opportunities.[21] In Kenya, turnover rates in public health neonatal units ranged from 30% to 40% per year, largely driven by burnout and low motivation.[20] Similarly, in South Africa, over 50% of neonatal nurses considered leaving their positions due to low wages, insufficient professional advancement options, and poor working conditions.[22] The average tenure of healthcare providers in ANN hospitals indicates that only 50% of neonatologists, and 36% of paediatricians and specialist nurses, have been in neonatal units for more than five years, which aligns with findings from similar studies that may note a concerning turnover rate.

Recommendations emphasize minimizing the rotation of staff specialized in the care of small and sick newborns in NICUs. Reducing such rotations is essential formaintaining continuity of care and fostering the development of specialized expertise among NICU staff. The ANN results reveal that 64% of nurses rotate across maternal and newborn child health units rather than remaining in neonatal units, possibly due to nursing shortages.[9,11,15] Retaining skilled staff in newborn units is vital for ensuring continuity of care, enhancing expertise, and ultimately improving outcomes for newborns.

The ANN initiative represents a significant step in advocating for appropriate staffing in neonatal units based on local realities rather than high-income country standards. Utilizing a standardized facility assessment over a consistent time frame lends reliability to the data collected. The diverse cohort of hospitals offers unique insights into various healthcare contexts including government, faith-based, and teaching hospitals. Additionally, the use of a standardized facility assessment over a consistent time frame enhances the reliability of the collected data. The diverse cohort of hospitals studied provides valuable insights into staffing in various healthcare contexts. However, the limited sample size of 14 hospitals restricts generalizability. Therefore, findings may not be representative of broader trends either within individual countries or across the continent.

Implications for the Future

The insights garnered from this research pave the way for a deeper understanding of current staffing practices in neonatal units and underscore an urgent need for standardized workforce criteria in LMICs. By addressing identified variations in staffing, it is possible for stakeholders to work collaboratively toward enhancing neonatal care and outcomes throughout Africa. Consequently, the data and recommendations from this study can support collective efforts to establish standardized staffing guidelines for African NICUs, ultimately improving neonatal health outcomes across the continent.

Acknowledgments

We are indebted to our colleagues at the following hospitals who submit data to VON on behalf of infants and their families: St. Paul's Millennium Medical College, Addis Ababa, Ethiopia; Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia; Tirunesh Beijing Hospital, Addis Ababa, Ethiopia; Assosa Hospital, Asosa, Ethiopia; Hawassa Referral Hospital, Awassa, Ethiopia; Ayder Hospital, Mekelle, Ethiopia; Sacred Heart Hospital, Abeokuta, Nigeria; Federal Teaching Hospital Ido-Ekiti, Ekiti, Nigeria; King Faisal Hospital, Kigali, Rwanda; Mengo Teaching Hospital, Kampala, Uganda; St Francis Nsambya Hospital, Kampala, Uganda; Lubaga Hospital, Kampala, Uganda; Murambinda Mission Hospital, Harare, Zimbabwe; Neocare Baby Hospital, Harare, Zimbabwe.

Funding: Bill and Melinda Gates Foundation INV-042791

References

1. World Health Organization. Global Health Estimates: Neonatal Mortality [Internet]. Geneva: World Health Organization, 2023. Available from https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates.
2. World Bank. Health and Mortality Statistics. Washington, DC: World Bank Group, 2023. Available from https://data.worldbank.org/topic/health.
3. World Health Organization, UNICEF. *Every Newborn: An Action Plan to End Preventable Deaths*. Geneva: World Health Organization; 2014.
4. UNICEF. Progress on the Sustainable Development Goals: The Situation of Children in Sub-Saharan Africa. New York: UNICEF, 2022. Available from https://www.unicef.org/reports/progress-sustainable-development-goals.
5. World Health Organization. Everybody's Business: Strengthening Health Systems to Improve Health Outcomes. Geneva, Switzerland: 2007.
6. Association of Women's Health, Obstetric, and Neonatal Nurses. Standards for professional registered nurse staffing for perinatal units. *J Obstet Gynecol Neonatal Nurs. 2022;51(4):e5-e98.*
7. Mader S, Thiele N, Walz, JM (ed). *European Standards of Care for Newborn Health project report*. Munich: Global Foundation for the Care of Newborns, 2018.
8. National Quality Board. Safe, sustainable and productive staffing: An improvement resource for neonatal care (Edition 1). London: National Health Service, 2018.
9. Horwood C, Haskins L, Phakathi S, McKerrow N. A health systems strengthening intervention to improve quality of care for sick and small newborn infants: results from an evaluation in district hospitals in KwaZulu-Natal, South Africa. *BMC Pediatr. 2019;19 (1):29.*
10. Kalyan, G., Joshi, P., Levis Murry, L., Campbell-Yeo, M., &Tiwarie, S. K. Transforming neonatal nursing in India: Challenges, opportunities, and the way forward. *Lancet Reg Health Southeast Asia. 2024;32:100522.*
11. World Health Organization. *Human Resource Strategies to Improve Newborn Care in Health Facilities in Low- and Middle-Income Countries*. Geneva: World Health Organization, 2020.
12. WHO-UNICEF Expert and Country Consultation on Small and/or Sick Newborn Care Group. A comprehensive model for scaling up care for small and/or sick newborns at district level–based on country experiences presented at a WHO-UNICEF expert consultation. *J Glob Health. 2023; 11:03023.*
13. March of Dimes, WHO, and Save the Children. *Born Too Soon: The Global Action Report on Preterm Birth*. Geneva: World Health Organization, 2012.
14. Helping Babies Breathe. Training Healthcare Providers in LMICs on Essential Newborn Care. Helping Babies Breathe initiative. 2020.
15. National Association of Neonatal Nurses. RN staffing in the NICU (Position Statement No. 3074), 2021. Available at: https://nann.org/uploads/RN_Staffing_in_the_NICU_Position_Statement.pdf
16. Lawn JE, Blencowe H, Oza S, You D, Lee AC, Waiswa P, Lalli M, Bhutta Z, Barros AJ, Christian P, Mathers C, Cousens SN; Lancet Every Newborn Study Group. Every Newborn: progress, priorities, and potential beyond survival. *Lancet. 2014;384(9938):189-205.* World Health Organization. State of the World's Nursing Report 2020: Investing in Education, Jobs, and Leadership. Geneva: World Health Organization, 2020.
17. Gathara D, Serem G, Murphy GAV, Obengo A, Tallam E, Jackson D, Brownie S, English M. Missed nursing care in newborn units: a cross-sectional direct observational study. *BMJ Qual Saf. 2020;29 (1):19-30.*
18. Feldman K, Rohan AJ. Data-driven nurse staffing in the neonatal intensive care unit. *MCN Am J Matern Child Nurs. 2022;47(5):249-264*.
19. Oluoch D, Murphy G, Gathara D, Abuya N, Nzinga J, English M, Jones C. Neonatal nursing policy and practice in Kenya: Key stakeholders and their views on task shifting as an intervention to improve care quality. Wellcome Open Research 2018,3:35.
20. Gebrekidan AY, Enaro EY, Azeze G, Adella GA, Kassie GA, Haile KE, Asgedom YS. Turnover intention among healthcare workers in Ethiopia: a systematic review and meta-analysis. *BMJ Open 2023;13(5):e067266.*
21. Ryan I, Shah KV, Barrero CE, Uamunovandu T, Ilbawi A, Swanson J. Task shifting and task sharing to strengthen the surgical workforce in sub-Saharan Africa: A systematic review of the existing literature. *World J Surg. 2023;47 (12):3070-3080.*