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Abstract

Introduction: Despite improved health service accessibility, neonatal mortality in Ethiopia remains high at 33 per 1,000 live births. Thus, improving health facilities' readiness across infrastructure, basic amenities, equipment, medications, laboratory services, Kangaroo Mother Care, infection prevention and control, staffing, and guidelines availability is critical for improving the quality of neonatal care and improving survival. Objective: To evaluate the readiness of Ethiopian hospitals to provide services to small and sick newborns. Methods: A cross-sectional study including 208 hospitals across four regions in Ethiopia in 2021–2024, prior to the phased implementation of the Saving Little Lives program. Data were collected using an adapted World Health Organization's Service Availability and Readiness Assessment tool and are presented using composite scores. Results: The mean composite readiness score for the 208 hospitals for providing services to small and sick newborns in labour and delivery wards was 59%, with domain-specific scores of 47% for basic amenities, 56% for essential neonatal care, and 74% for newborn resuscitation. Significant variation was seen across hospital levels, and basic amenities were available in 68%, 49%, and 43%, essential neonatal care in 68%, 81%, and 71%, and newborn resuscitation in 68%, 66%, and 50% of referral, general, and primary hospitals, respectively. The mean composite readiness score to provide newborn care in the neonatal care units was 57%. Scores varied by hospital levels, with scores of 73%, 64%, and 50% for referral, general, and primary hospitals, respectively. Domain-specific scores were 63% for basic amenities, 65% for equipment, 67% for medications, 63% for laboratory services, 25% for Kangaroo Mother Care, 68% for infection prevention and control, 55% for staffing, and 51% for guidelines. Functional bCPAP machines were available in 14% of labour and delivery wards and in 35% of neonatal care units. Conclusion: There is a substantial gap in readiness to provide care for small and sick newborns, and significant variations across hospital levels. Immediate actions must be taken to address the observed

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gaps to reach the sustainable development goal of reducing neonatal mortality to at least 12 per 1,000 live births by 2030.

Keywords: saving little lives program; readiness; newborn care services

1. Introduction

Neonatal mortality remains a critical global health challenge. In 2022, an estimated 4.9 million children under five years of age died, and 47% of these deaths occurred in the first 28 days of life. Sub-Saharan Africa accounts for 57% of under-five deaths and 46% of neonatal deaths. While overall under-five mortality has declined since 1990, the proportion of neonatal deaths increased from 41% in 2000 to 47% in 2022 [1]. According to the World Health Organization (WHO), an estimated 20 million infants are born with low birth weight (LBW) each year, and approximately 15 million are born preterm [2]. In 2020, an estimated 80% of neonatal deaths occurred among LBW infants, and nearly two-thirds of deaths were among those born prematurely [3].

Ethiopia has a high neonatal mortality rate of 33 per 1,000 live births, with approximately 107,000 neonatal deaths annually, accounting for 56% of under-five deaths [1,4]. Complications from prematurity are the leading cause, including respiratory distress syndrome (RDS) (45%), infections (30%), and birth asphyxia (14%) [5–7].

Although cause-specific neonatal mortality varies by geographical area, it is largely attributed to poor quality of care at birth and during the early neonatal period, estimated to contribute to 61% of neonatal deaths [7,8]. With high-quality health systems, it is estimated that one million newborn deaths can be prevented each year [6,7].

Therefore, improving both access to and quality of care is critical and requires actions to ensure neonatal survival [9,10]. The readiness of hospitals is an essential prerequisite for ensuring service quality, including infrastructure, basic amenities, equipment, medications, laboratory services, trained healthcare providers (HCPs), and guideline availability [11].

To address the stagnant neonatal mortality rate, Ethiopia has implemented key interventions such as establishing dedicated newborn wards, training HCPs, and establishing and equipping neonatal care units (NCUs) across different hospital levels. Referral hospitals are expected to offer specialized level 3 care, general hospitals to deliver level 2 care, and primary hospitals to provide basic level 1 care. All hospitals are required to have a Kangaroo Mother Care (KMC) ward for eligible preterm and LBW infants [12].

Despite improved service accessibility, persistent challenges such as uneven resource distribution, poor quality of care, low KMC coverage, low community care-seeking behaviour, and shortages of essential commodities and equipment at service delivery points remain key challenges contributing to the high neonatal mortality rate in Ethiopia.

Addressing these problems requires an understanding of national newborn care priorities, and comprehensive facility assessments need to be made to determine how to improve facility readiness, healthcare provider competencies, provider-patient interactions, and working environments [11,13].

From January 2021 to June 2024, the Ethiopian government with the support from the World Bank's Global Financing Facility (GFF) implemented the Saving Little Lives (SLL) program, aiming to reduce neonatal deaths by 35% through achieving 80% coverage of evidence-based interventions targeting hospitalized preterm and LBW infants. The program's success depended on the readiness and availability of functional health infrastructures, medical equipment, and medications as well as on the availability of adequate and trained healthcare providers in the hospitals to deliver quality neonatal care.

This study was conducted to assess the readiness of hospitals included in the program to provide care to small and sick newborns prior to the implementation of the SLL program and generate actionable information about the readiness and availability of neonatal care services in Ethiopia.

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2. Materials and Methods

2.1. Study Design, Setting, and Inclusion Critieria

This facility-based cross-sectional study was part of the SLL program that aimed at reducing the neonatal mortality rate by 35% through achieving 80% coverage of evidence-based interventions.

The SLL program targeted 290 hospitals (206 primary, 69 general, and 15 referral hospitals) representing 82% of all hospitals in the country at the time of the study across four regions (Oromia, Amhara, Tigray, and Southern Nations, Nationalities, and People (SNNP)), covering a total population of estimated 76.2 million and 1.2 million births (34% of national births). These hospitals in the four regions were selected for SLL program implementation based on their high delivery volume, neonatal mortality rates, and alignment with government priorities.

Among the 290 hospitals, data were not collected from 82 hospitals due to security challenges at the time of the assessment, their remote locations, or resource constraints. Therefore, data from 208 hospitals of all levels across the four regions were included in the final analysis, including 22 referral, 56 general, and 130 primary hospitals.

The SLL program was designed to be implemented in three phases, each lasting a year. Data on the readiness of hospitals to provide care for small and sick newborns were collected prior to SLL implementation from March to May 2021, July to August 2022, and December 2023 to January 2024, including 72, 115, and 21 hospitals, respectively.

2.2. SLL Program Interventions

The SLL program was designed to implement evidence-based minimum care packages interventions to small and sick newborns, targeting the primary drivers of neonatal mortality: prematurity, asphyxia, and sepsis. Across the continuum of neonatal care, the SLL minimum care packages focused on care at birth in labour and delivery (L&D) wards, in the NCUs, and in the KMC ward.

The minimum care package at birth included birth preparation and essential newborn care, including resuscitation for asphyxiated infants, respiratory support for preterm infants, infection prevention and control (IPC), thermal care, early breastfeeding initiation, and timely safe referral. The NCU care package included IPC and sepsis management, the use of a bubble CPAP (bCPAP) for RDS, thermal care, feeding support, and management of perinatal asphyxia. The KMC package consisted of exclusive breastfeeding and skin-to-skin contact.

The SLL minimum care packages were cascaded through training and clinical mentorship to enhance HCPs` knowledge and skills. Additionally, hospitals received essential medical equipment and supplies as well as support for renovations or redesigns in L&D wards and NCUs in selected hospitals and implementation follow-up and supervision.

2.3. Variables

The readiness to provide services to small and sick newborns was assessed based on the availability of infrastructure with service delivery rooms in the L&D wards and NCUs, electric power, functional water hygiene and sanitation (WASH) infrastructure, basic amenities, equipment, medications, staffing, and guideline availability.

The variables assessed were the L&D wards and NCUs' availability of items required for each domain of neonatal care. These included a total of 33 variables across three main domains related to neonatal care in the L&D wards, including 8 variables for basic amenities, 14 for neonatal resuscitation, and 11 for essential newborn care. In the NCUs, 108 variables for 8 domains were assessed, including 16 for basic amenities, 26 for basic equipment, 16 for essential medications, 14 for laboratory investigations, 11 for KMC, 11 for IPC, 6 for staffing – including trained nurses and general practitioners, paediatricians, and support staff (porters, cleaners, and security guards) – and 8 for guideline availability.

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2.4. Data Collection

Prior to the implementation of SLL program interventions, data on hospitals' readiness to provide care for small and sick newborns were collected by six to eight trained program research assistants in each region. The data collection process was supervised by SLL program evaluation coordinators and regional program managers.

Data collectors and supervisors received a two-day training on the data collection tool and methods. Data were gathered using an adapted WHO's Service Availability and Readiness Assessment (SARA) tool through interviews with HCPs and unit heads, register reviews, and direct observations of infrastructure in the L&D wards and the NCUs, medical equipment, medications, handwashing facilities, and and guideline availability. The data were collected electronically via the Open Data Kit application, transferred to Excel, and thoroughly checked for completeness and accuracy, with corrections being made as needed.

2.5. Data Analysis

Data analysis was performed using STATA statistical software, version 17. All categorical variables were summarized using proportions and are presented in tables and graphs. For each item, an item score of 0 or 1 was assigned according to whether the item was available or not at a facility. Next, the percentage of facilities where the item was available was calculated. Readiness scores for each domain were computed as the mean percentage of the items within that domain. A composite readiness score was then calculated by aggregating the domain scores.

The overall readiness was calculated as the mean of the scores for each domain, thus giving equal weight to each of the three domains for the L&D wards and the eight domains for the NCUs. A comparison of item scores within domains across different levels of explanatory variables was conducted. Chi-square tests were used to test for the associations between categorical variables. A p-value of <0.05 was considered to indicate a statistically significant association.

3. Results

In total 208 public hospitals across all levels were included, 22 (11%) referral hospitals, 56 (27%) general hospitals, and 130 (63%) primary hospitals.

Readiness to provide small and sick newborn care in the L&D wards

Readiness to provide small and sick neonatal care in L&D wards was 47% for basic amenities, 74% for essential newborn care, and 56% for neonatal resuscitation, with an overall mean readiness score of 59% (Figure 1). The overall mean readiness score varied by hospital levels, and referral hospitals scored 65%, general hospitals 62%, and primary hospitals 54% (Figure 2).

The readiness of L&D wards for basic amenities varied by hospital level, with scores of 68% in referral hospitals, 49% in general hospitals, and 43% in primary hospitals. For essential newborn care, the readiness scores were 68% in referral hospitals, 81% in general hospitals, and 71% in primary hospitals. Approximately 70% of referral and general hospitals were equipped for neonatal resuscitation, while only 50% of primary hospitals (Tables 1, 4 and 5).

Table 1. Availability of basic amenities in the labour & delivery ward by hospital level.

	Referral		General		Primary		Overall		p-value
Variables	**n**	**n (%)**	**n**	**n (%)**	**n**	**n (%)**	**n**	**n (%)**	
Functional hand washing stations in:									
Prenatal room	21	14 (67)	51	16 (31)	126	34 (27)	198	64 (32)	0.00
Delivery room	22	17 (77)	56	28 (50)	130	60 (46)	208	105 (50)	0.03
Postnatal room	21	10 (48)	51	9 (18)	126	27 (21)	198	46 (23)	0.02
Curtains & bed screens in each bed in:									
Prenatal room	21	9 (43)	51	14 (27)	82	21(26)	154	44 (29)	0.29
Delivery room	22	12 (55)	56	25 (45)	130	54 (42)	208	91 (44)	0.52
Postnatal room	21	13 (62)	51	12(24)	82	10 (12)	154	35 (23)	0.00
Nursing station	21	20 (95)	51	41 (80)	126	109 (87)	198	170 (86)	0.24
Toilet with shower adjacent to ward	22	12 (55)	56	31(55)	130	63 (48)	208	106 (51)	0.65

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Uninterrupted electricity supply	22	17 (77)	56	38 (68)	130	45 (35)	208	100 (48)	0.00
Automatic backup generator	22	20 (91)	56	34 (61)	130	73 (56)	208	127 (61)	0.01
Uninterrupted water supply	22	13 (59)	56	31 (55)	130	30 (23)	208	74 (36)	0.00
Single entrance to control access	21	17 (81)	51	37 (73)	124	112 (90)	196	166 (85)	0.01
Mean readiness score		**68**		**49**		**43**		**47**	

Readiness to provide small and sick newborn care in NCUs

The readiness for small and sick neonatal care in NCUs was measured across eight domains, including amenities (63%), basic equipment (65%), essential medications (67%), laboratory investigations (63%), KMC (25%), IPC (68%), staffing (55%), and guideline availability (51%). The overall readiness score was 57% (Figure 1) and varied by hospital level: referral hospitals scored 73%, general hospitals 64%, and primary hospitals 50% (Figure 2).

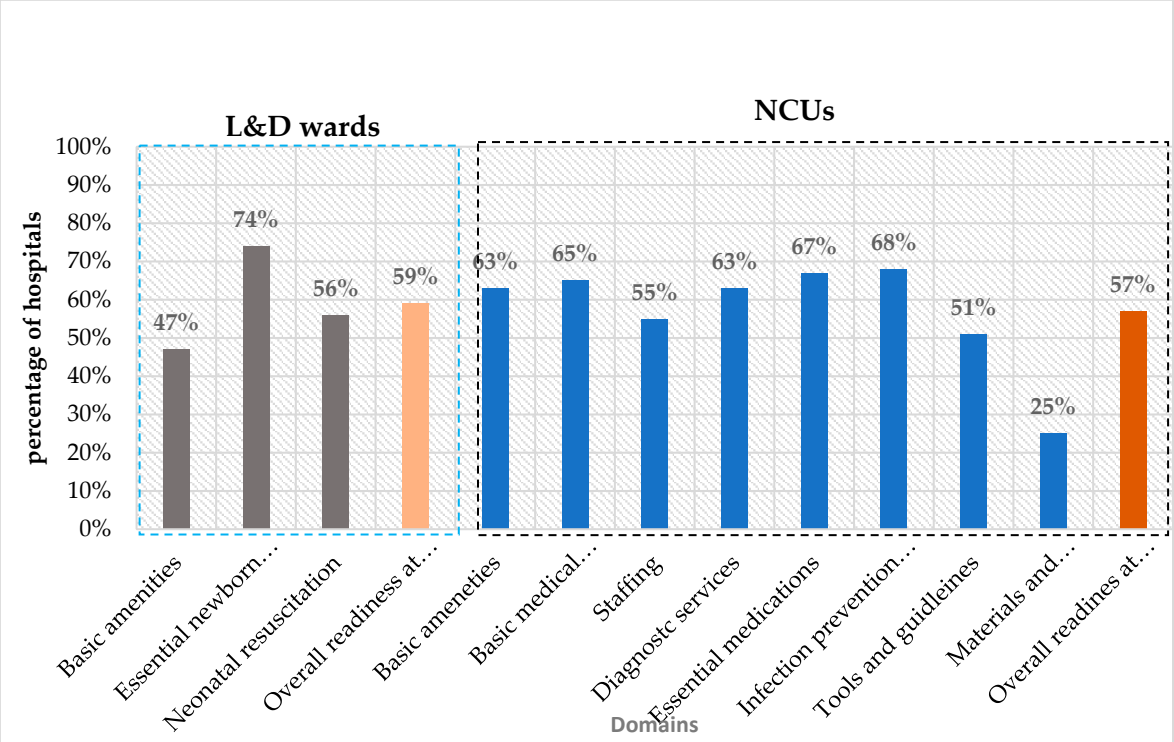

Figure 1. Mean readiness scores by key domains in L&D wards and NCUs.

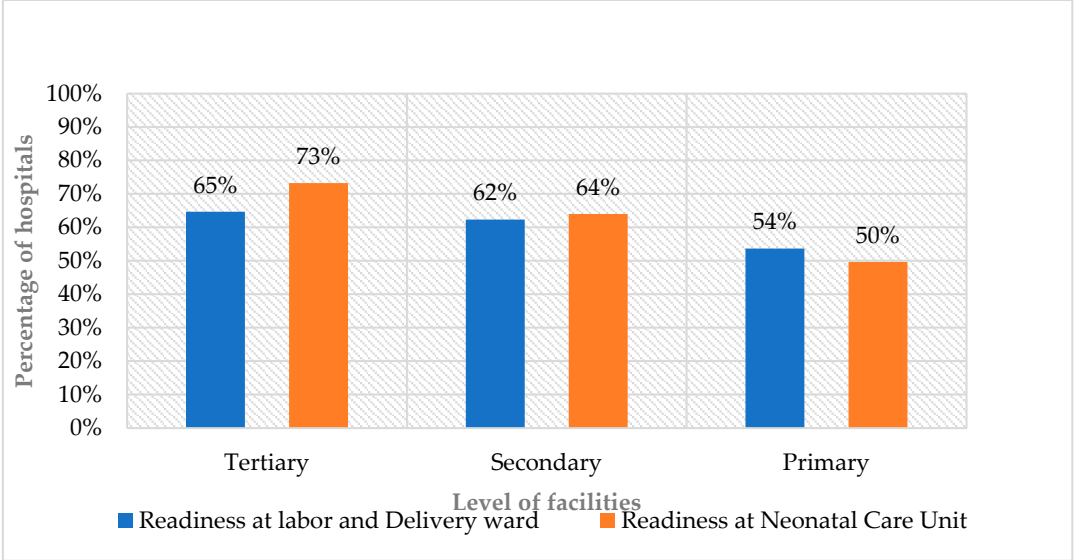

Figure 2. Readiness scores in L&D wards and NCUs by hospital level.

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Availability of basic amenities in the L&D wards and NCUs

Functional handwashing facilities were available in 64 (32%) of the prenatal rooms, 105 (50%) of the delivery rooms, 46 (23%) of the postnatal rooms, and 113 (55%) of the NCUs of the assessed hospitals ($p<0.05$). Functional toilets with showers near the units were available in 106 (51%) of the L&D wards and in 83 (40%) of the NCUs.

Uninterrupted power supply was available in 124 (59%) of L&D wards and 100 (48%) of the NCUs. In the event of a power outage from the national grid, a backup power source was present in 127 (61%) of the hospitals ($p<0.05$). Uninterrupted water supply was available in only 74 (36%) of the hospitals.

There was a variation in the mean readiness scores for basic amenities across hospital levels in L&D wards and NCUs. In L&D wards, referral hospitals had a mean basic amenities readiness score of 67%, general hospitals 48%, and primary hospitals 46%. In NCUs, referral hospitals had a readiness score of 77%, general hospitals 65%, and primary hospitals 57% (Table 2 and Table 3).

Table 2. Availability of basic amenities in NCUs by hospital level.

Variables	Tertiary		General		Primary		Overall		p-value
	n	n (%)	n	n (%)	n	n (%)	n	n (%)	
Separate space for NCU	22	22 (100)	56	56 (100)	130	127 (98)	208	205 (99)	0.40
NCU is located adjacent to delivery room	21	11 (52)	51	29 (57)	123	110 (89)	195	150 (77)	0.00
Direct access to transport receiving area	17	13 (76)	34	19 (56)	17	14 (82)	68	46 (68)	0.11
Rooms for critical, sub-critical, and stable cases	21	18 (86)	45	27 (60)	51	24 (47)	117	69 (59)	0.01
Triaging room	21	18 (86)	51	22 (43)	42	5 (12)	114	45 (39)	0.00
Procedure room	13	10 (76)	43	22 (51)	16	5 (31)	72	37 (51)	0.05
IV drugs and fluid preparation area	22	18 (82)	56	42 (75)	130	92 (71)	208	152 (73)	0.52
Gowning area at the entrance	21	15 (71)	48	32 (67)	94	60 (64)	163	107 (66)	0.79
Nurses station/staff work area	22	15 (68)	54	39 (72)	122	94 (77)	198	148 (75)	0.59
Workspace for doctor/nurse on duty	22	18 (82)	56	37 (66)	65	36 (55)	143	91 (64)	0.07
One or two rooms with 4–6 maternal beds	21	16 (76)	51	33 (65)	79	23 (29)	151	72 (48)	0.00
Uninterrupted water supply in each room	22	13 (59)	56	31 (55)	130	30 (23)	208	74 (36)	0.00
Functional hand washing facilities	22	17 (77)	54	40 (74)	130	56 (43)	206	113 (55)	0.00
Toilet and shower area	22	15 (68)	55	18 (33)	130	50 (38)	207	83 (40)	0.01
Uninterrupted 24 h stabilized power supply	22	17 (77)	56	41 (73)		66 (51)	208	124 (60)	0.00
24 h service availability	22	22 (100)	54	50 (93)	130	127 (98)	206	199 (97)	0.14
Mean readiness score		**77**		**65**		**57**		**63**	

Table 4. Availability of basic supplies and equipment for essential newborn care at the L&D ward by hospital level.

Variables	Tertiary		General		Primary		Overall		p-value
	n	n (%)	n	n (%)	n	n (%)	n	n (%)	
Vitamin K	22	19 (86)	56	51 (91)	130	108 (83)	208	178 (86)	0.36
TTC eye ointment	22	19 (86)	56	51 (91)	130	116 (89)	208	186 (89)	0.82
Chlorhexidine 4% gel	21	14 (67)	51	34 (67)	126	85 (67)	198	133 (67)	0.99
Baby weighing scale	17	16 (94)	51	49 (96)	123	119 (97)	191	184 (96)	0.85
Sterile scissors and/or blades	17	16 (94)	27	27(100)	81	81 (100)	125	124 (99)	0.04
Umbilical cord clamp	17	15 (88)	27	26 (96)	81	77 (95)	125	118 (94)	0.48
Clean blankets, towels, and linens	17	3 (18)	27	15 (56)	81	38 (47)	125	56 (45)	0.03
Wall clock	22	9 (41)	55	37 (67)	127	46 (36)	204	92 (45)	0.00
Measuring tape	18	10 (56)	52	39 (75)	119	60 (50)	189	109 (58)	0.01
Stethoscope	20	17 (85)	50	42 (84)	100	63 (63)	170	122 (72)	0.01
Baby crib	7	2 (29)	39	28 (72)	91	49 (54)	137	79 (58)	0.04
Mean readiness score		**68**		**81**		**71**		**74**	

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Availability of supplies and equipment for essential newborn care

The readiness scores for essential newborn care also varied by hospital level, with referral hospitals scoring 68%, general hospitals 81%, and primary hospitals 71%. The overall mean readiness score of all the hospital levels was 74% (Table 4).

Availability of equipment and supplies for newborn resuscitation

Approximately 90% of hospitals had designated places for neonatal resuscitation. However, only about 56% of hospitals fulfilled basic neonatal resuscitation equipment and supplies. Specifically, only 86 (47%) of the hospitals had neonatal-sized bags and masks, 43 (35%) had self-inflating bags and masks, 68 (54%) had mucus extractors, 66 (47%) had functional oxygen tubing, and 66 (47%) had functional pulse oximeters ($p<0.05$).

Additionally, standard and/or home-grown bCPAP was available in only 16 (14%) of the hospitals within their L&D wards ($p<0.01$). The mean readiness score for neonatal resuscitation differed by hospital level and was 68% in referral hospitals, 66% in general hospitals, and 50% in primary hospitals (Table 5).

Table 5. Neonatal resuscitation space, equipment, and supply availability overall and by hospital level in L&D wards.

Variables	Referral		General		Primary		Overall		p-value
	n	n (%)	n	n (%)	n	n (%)	n	n (%)	
Space/corner	22	20 (91)	56	51 (91)	130	115 (88)	208	186 (89)	0.84
Warmer	18	15 (83)	38	29 (76)	83	72 (87)	139	116 (83)	0.36
Suction pump (electrical)	21	10 (48)	42	26 (62)	93	38 (41)	156	74 (47)	0.08
Suction pump (manual)	22	20 (91)	55	44 (80)	129	96 (74)	206	160 (78)	0.20
Functional oxygen cylinder	16	16 (100)	27	20 (74)	81	51(63)	124	87 (70)	0.01
Functional oxygen concentrator	16	9 (56)	52	45 (87)	118	83 (70)	186	137 (74)	0.02
bCPAP machine and/or indigenous	16	5 (31)	27	10 (37)	75	1 (1)	118	16 (14)	0.00
Neonatal size bag, self-inflating	22	13 (59)	56	38 (68)	104	35 (34)	182	86 (47)	0.00
Neonatal size face masks (size 0-1)	16	14 (88)	28	25 (89)	56	43 (77)	100	82 (82)	0.31
Nasal prongs, 1 mm and 2 mm	17	10 (59)	27	16 (59)	87	37 (43)	131	63 (48)	0.20
Laryngoscope, neonatal size	12	4 (33)	11	2 (18)	59	7 (12)	82	13 (16)	0.17
Mucus extractor	16	11 (69)	27	16 (59)	79	16 (20)	122	43 (35)	0.00
Oxygen tubing	17	11 (65)	28	20 (71)	81	37 (46)	126	68 (54)	0.04
Functional pulse oximeter	17	13 (76)	28	14 (50)	96	39 (41)	141	66 (47)	0.02
Mean readiness score		**68**		**66**		**50**		**56**	

Readiness for newborn care in NCUs

Infrastructure: Nearly all 205 (99%) of the hospitals had designated spaces for NCUs in the hospitals. However, only 69 (59%) of the hospitals had separate rooms dedicated for critically ill, sub-critically ill, and stable infants. The availability of separate rooms in the NCUs varied by hospital level, and 86% of referral hospitals had dedicated spaces for critically ill, sub-critically ill, and stable infants compared to 60% of general hospitals and 47% of primary hospitals ($p<0.05$).

In addition, most hospitals lacked dedicated rooms within the NCU for triage procedures and did not have an adequate number of beds for mothers ($p<0.05$) (Table 2).

Availability of medical equipment and supplies in NCUs

The overall availability of basic equipment in NCUs was 65%, with wide variation across facility levels: 81% in referral hospitals, 74% in general hospitals, and 59% in primary hospitals. Only 72 (35%) of NCUs had functional bCPAP devices, with availability being the highest in referral hospitals 17 (77%), followed by general hospitals 27 (49%), and primary hospitals 28 (22%) ($p<0.05$). Less than half of the hospitals 89 (43%) had room thermometers, with approximately 60% of referral and general hospitals compared to only 44 (34%) of primary hospitals.

Additionally, the availability of other essential equipment varied, and room warmers were present in 144 (73%) of hospitals' NCUs, phototherapy machines in 148 (72%), digital weighing scales

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in 139 (67%), electrical suction pumps in 107 (53%), pulse oximeters in 156 (75%), and bag-mask self-inflating resuscitators in 122 (60%), $p < 0.05$ (Table 6).

Table 6. Availability of basic medical equipment at NCUs by hospital level.

Items	Referral		General		Primary		Overall		
	n	n (%)	n	n (%)	n	n (%)		n (%)	p-value
NCU Bed	22	22 (100)	45	43 (96)	129	122 (95)	196	187 (95)	0.53
Radiant warmers	22	22 (100)	56	54 (96)	130	116 (89)	208	192 (92)	0.09
Room warmers	21	11 (52)	4-	40 (80)	126	93 (74)	197	144 (73)	0.05
Room thermometer	22	13 (59)	55	32 (58)	130	44 (34)	207	89 (43)	0.00
Oxygen cylinder, 20 litres	21	20 (95)	40	35 (88)	120	112 (93)	181	167 (92)	0.42
Phototherapy	22	21 (95)	55	48 (87)	128	79 (62)	205	148 (72)	0.00
Neonatal resuscitator, hand operated, 250 ml	11	8 (73)	32	23 (72)	77	33 (43)	120	64 (53)	0.01
Suction bulb	22	17 (77)	56	43 (77)	128	88 (69)	206	148 (72)	0.45
Portable electrical suction pump	18	16 (89)	53	35 (66)	130	56 (43)	201	107 (53)	0.00
IV infusion pump	22	19 (86)	56	32 (57)	130	36 (28)	208	87 (42)	0.00
Syringe pump	22	20 (91)	50	38 (76)	124	84 (68)	196	142 (72)	0.07
Oxygen concentrators	21	18 (86)	49	43 (88)	130	111 (85)	200	172 (86)	0.92
Incubators	22	19 (86)	56	47 (84)	129	97 (75)	207	163 (79)	0.27
Glucometer	22	21 (95)	55	44 (80)	130	93 (72)	207	158 (76)	0.04
Digital thermometer, clinical	22	20 (91)	54	50 (93)	129	121 (93)	205	191 (93)	0.87
Weighing scale neonate (Digital)	22	17 (77)	54	42 (78)	130	80 (61)	206	139 (67)	0.06
Pulse oximeter, neonatal	22	20 (91)	56	48 (85)	129	88 (68)	207	156 (75)	0.01
Stethoscope, neonatal	15	12 (80)	45	36 (80)	130	69 (53)	190	117 (62)	0.00
Tape measure, vinyl-coated, 1.5 m	15	8 (53)	45	32 (71)	124	80 (64)	184	120 (65)	0.44
Infusion stands	14	13 (93)	50	41 (82)	112	85 (75)	176	139 (79)	0.28
bCPAP with a compressor	22	17 (77)	55	27 (49)	130	28 (22)	207	72 (35)	0.00
Gown and shoes for the providers	21	15 (71)	51	29 (57)	120	59 (49)	192	103 (54)	0.15
Refrigerator for drugs	22	20 (90)	55	28 (51)	130	12 (9)	207	60 (29)	0.00
Bag and mask, self-inflating	22	14 (63)	53	42 (79)	130	66 (51)	205	122 (60)	0.00
Laryngoscope	19	13 (68)	45	22 (49)	105	17 (16)	169	52 (31)	0.00
Mobile examination lights, ≥ 2	19	11 (58)	48	23 (48)	120	47 (39)	187	81 (43)	0.24
Mean readiness score		**81**		**74**		**59**		**65**	

Staffing at NCUs

The majority 188 (90%) of NCUs had nurses trained in neonatal intensive care. Paediatricians were available in 54 (40%) of hospitals, while trained general practitioners were present in 107 (54%) of hospitals. The availability of paediatricians varied significantly by facility level, 95% of referral hospitals, 55% of general hospitals, and only 6% of primary hospitals. The mean readiness score for the availability of key NCU staffing varied by facility level and was 79% in referral hospitals, 56% in general hospitals, and 47% in primary hospitals, with an overall mean of 55% (Table 7).

Table 7. Key staffing availability at the NCU by hospital level.

Items	Referral		General		Primary		Overall		
	n	n (%)	n	n (%)	n	n (%)	n	n (%)	p-value
NCU trained nurses	22	21 (95)	56	54 (96)	130	113 (87)	208	188 (90)	0.09
Paediatricians	22	21 (95)	55	30 (55)	57	3 (6)	134	54 (40)	0.00
Trained general practitioner	19	11(58)	56	31 (55)	124	65 (52)	199	107 (54)	0.87
Porters	22	18 (82)	43	11 (25)	124	42 (33)	189	71 (38)	0.00
Cleaners	22	21 (95)	39	34 (87)	120	100 (83)	181	155 (86)	0.31
Guards	22	11(50)	54	9 (16)	124	28 (23)	200	48 (24)	0.01
Mean readiness score		**79**		**56**		**47**		**55**	

Availability of essential medications

A total of 16 essential medications across seven categories were assessed, including antimicrobials, neurologic, inotropes, bronchodilators, corticosteroids, vitamin K, and intravenous infusions for treating small and sick newborns. No health facility reported a complete stock of all 16 medications. The overall readiness score for essential medications was 67%.

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More than 90% of hospitals had essential antibiotics such as ampicillin, gentamycin, and ceftriaxone and intravenous fluids and antiseptics, but fewer than half stocked ceftazidime, ciprofloxacin, intravenous azithromycin, or vancomycin.

First-line antimicrobials like ampicillin, gentamicin, and cloxacillin were available in 80% of referral hospitals, 82% of general hospitals, and 81% of primary hospitals. In contrast, second-line drugs were available in only 47% of referral hospitals, 54% of general hospitals, and 33% of primary hospitals. The readiness for essential medications varied across hospital levels at 74% for referral hospitals, 74% for general hospitals, and 61% for primary hospitals (Table 8).

Table 8. Availability of basic medications in the NCU by hospital level.

Drugs	Referral		General		Primary		Overall		p-value
	n	n (%)	n	n (%)	n	n (%)	n	n (%)	
Ampicillin	21	20 (95)	50	46 (92)	126	123 (98)	197	189 (96)	0.23
Gentamycin	22	18 (82)	51	49 (96)	126	115 (91)	199	182 (91)	0.13
Ceftriaxone	21	17 (81)	50	46 (92)	126	114 (90)	197	177 (90)	0.35
Cloxacillin	21	13 (62)	40	23 (58)	126	68 (54)	187	104 (56)	0.77
Ceftazidime	14	4 (29)	40	17 (43)	120	41 (34)	174	62 (36)	0.54
Ciprofloxacin	14	7 (50)	41	26 (63)	50	5 (10)	105	38 (36)	0.00
Azithromycin IV	14	2 (14)	34	5 (15)	50	2 (4)	98	9 (9)	0.19
Vancomycin	13	8 (62)	34	20 (59)	50	14 (28)	97	42 (43)	0.01
Tetracycline eye ointment	20	13 (77)	51	44 (86)	126	95 (75)	197	152 (77)	0.12
Vitamin K ampoules	21	16 (76)	51	45 (88)	126	86 (68)	198	147 (74)	0.02
IV fluids (N/S, 5% D/W, 40% glucose)	21	21 (100)	51	48 (94)	124	116 (94)	196	185 (94)	0.49
Antiseptics	21	19 (90)	51	49 (96)	125	120 (96)	197	188 (95)	0.52
Adrenaline amp.	13	12 (92)	32	26 (81)	35	18 (51)	80	56 (70)	0.01
Aminophylline amp.	14	14 (100)	34	25 (74)	50	22 (44)	98	61(62)	0.00
Dexamethasone injection	14	14 (100)	40	33 (83)	85	63 (74)	139	110 (79)	0.07
Phenobarbital	14	11 (79)	40	24 (60)	119	70 (59)	173	105 (61)	0.36
Mean score		**74**		**74**		**61**		**67**	

Availability of basic diagnostic services

More than two-thirds of the hospitals surveyed could perform essential laboratory tests, including random blood sugar, blood grouping and Rhesus factor, urine analysis, stool examination, and ultrasound. In contrast, fewer than a quarter could perform culture and sensitivity testing, and only 35% offered bilirubin testing or blood morphology assessments.

The mean readiness for laboratory investigations was lower in primary hospitals compared to general and referral hospitals. The overall mean readiness score for laboratory investigations across all studied hospitals was 63% (Table 9).

Table 9. Availability of basic diagnostic services by hospital level.

Items	Referral		General		Primary		Overall		p-values
	n	n (%)	n	n (%)	n	n (%)		n (%)	
HCT or Hgb	18	14 (78)	40	30 (75)	104	73 (70)	162	117 (72)	0.73
CBC	18	14 (78)	40	28 (70)	105	56 (53)	163	98 (60)	0.05
Random blood sugar	16	16 (89)	40	31 (78)	105	83 (79)	163	130 (80)	0.58
Blood group & Rh factor	11	9 (82)	40	30 (75)	105	80 (76)	156	119 (76)	0.89
Bilirubin total & direct	10	6 (60)	34	19 (56)	52	8 (15)	96	33 (34)	0.00
Blood Morphology	7	4 (57)	34	11 (32)	11	3 (27)	52	18 (35)	0.39
Blood Film	11	10 (90)	40	31 (78)	82	52 (63)	133	93 (70)	0.08
ESR	11	6 (55)	40	28 (70)	82	39 (48)	133	73 (55)	0.06
VDRL	10	7 (70)	40	29 (73)	105	73 (70)	155	109 (70)	0.94
Urine analysis	11	8 (73)	40	36 (90)	105	79 (75)	156	123 (79)	0.13
Stool exam	11	8 (73)	40	38 (95)	105	81 (77)	156	127 (81)	0.04

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Culture and sensitivity of any fluid	5	5 (71)	34	5 (15)	11	0	52	10 (19)	0.00
X-Ray	15	11 (73)	34	27 (79)	50	32 (64)	99	70 (71)	0.30
Ultrasound	13	12 (92)	36	20 (56)	34	30 (88)	83	62 (75)	0.00
Mean readiness score		**74**		**67**		**58**		**63**	

Infection Prevention and Control supplies

The overall mean readiness score for IPC in the NCUs was 68%. The availability of IPC supplies in NCUs varied across hospitals, and IPC readiness was lower in primary hospitals than in general and referral hospitals. Although alcohol-based hand sanitizers were available in 117 (94%) of the hospitals, the availability of functional handwashing stations differed significantly by facility level at 77% in referral hospitals, 74% in general hospitals, and only 43% in primary hospitals. This disparity highlights the inequitable distribution of basic IPC infrastructure, particularly in lower-level hospitals, which may compromise newborn care and increase the risk of healthcare-associated infections.

Additionally, 91 (74%) of the hospitals had adequate antiseptic solutions, including 7% chlorhexidine, ethanol, povidone-iodine, and disinfectants. Sterile gloves and puncture-proof sharps containers were available in more than three-quarters of the hospitals studied (See Table 10).

Table 10. Availability of infection prevention supplies at the NCU by hospital level.

Items	Referral n = 16 n (%)	General n = 27 n (%)	Primary n = 81 n (%)	Overall n = 124 n (%)	p-value
Alcohol-based hand rub	15 (94)	27 (100)	75 (93)	117 (94)	0.35
Adequate antiseptics (chlorhexidine 7%, ethanol, povidone-iodine)	15 (94)	19 (70)	57 (70)	91 (74)	0.14
Functional hand washing facilities	15 (94)	27 (100)	25 (31)	67 (54)	0.00
Contaminated waste bins with different colours	11 (68)	21 (79)	37 (46)	69 (55)	0.01
Disinfectant solutions (e.g. chlorine bleach)	16 (100)	25 (92)	70 (86)	111 (90)	0.23
Adequate disposable gloves	14 (87)	20 (74)	41 (50)	75 (60)	0.01
Gloves (sterile)	15 (94)	24 (89)	52 (64)	91 (73)	0.01
Regular trash/waste bin	13 (81)	26 (96)	36 (44)	75 (60)	0.00
Receptacle for soiled linen	10 (63)	19 (70)	24 (29)	53 (43)	0.00
Sharps containers (puncture proof)	14 (88)	24 (89)	74 (91)	112 (90)	0.86
Autoclave	6 (38)	22 (81)	36 (44)	64 (52)	0.00
Mean readiness score	**82**	**86**	**59**	**68**	

Availability of guidelines in the NCU

The presence of guidelines varied by guideline type and facility level. Neonatal logbooks were mostly available in 187 (94%) hospitals followed by NCU training guidelines. The IPC national manual, KMC registers, the KMC flow chart/patient chart, feeding and weight charts, preterm care registration books, and preterm care counselling chart booklets were available in fewer than half of the hospitals. The mean readiness for guidelines and tools was 51% at the NCUs of the studied hospitals (Table 11).

Table 11. Availability of guidelines at the NCU by hospital level.

	Referral		General		Primary		Overall		
Items	n	n (%)	n	n (%)	n	n (%)	n	n (%)	p-value
NCU training guideline	15	12 (80)	25	23 (92)	75	49 (65)	115	84 (73)	0.03
IPC national manual	11	10 (91)	21	11 (52)	49	17 (34)	81	38 (47)	0.00
KMC registers	15	7 (47)	26	13 (50)	75	8 (11)	116	28 (24)	0.00
KMC flow chart/patient chart; feeding and weight	20	14 (70)	55	37 (67)	130	48 (36)	205	99 (48)	0.00
Neonatal logbook	21	20 (95)	54	51 (94)	123	116 (94)	198	187 (94)	0.99
Preterm care registration book	17	11 (65)	40	17 (43)	79	16 (20)	136	44 (32)	0.00
Preterm care counselling chart booklet	14	8 (57)	42	17 (40)	94	11 (12)	150	36 (24)	0.00
MPDSR audit	12	12 (100)	25	18 (72)	75	44 (59)	112	74 (66)	0.02

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Mean readiness score	**75.6**	**63.8**	**41.4**	**51.0**

Availability of materials and supplies for KMC provision

In this study, nearly three-fourths (72%) of the hospitals had designated rooms for KMC. However, among hospitals with KMC rooms, only 31 (16%) had KMC wraps and only 17 (9%) had gowns for mothers ($p<0.05$). Comfortable chairs were available in 29 (14%) of the hospitals, and reclining beds with privacy curtains were available in 106 (51%) of the hospitals. Additionally, only 16 (8%) of hospitals had televisions to educate mothers on KMC.

The overall readiness for KMC was found to be very low across all facility levels, with a mean readiness score of 25%, with referral hospitals scoring 43%, general hospitals 26%, and primary hospitals 15% (Table 11).

Table 11. Availability of materials and supplies for KMC service by hospital level.

	Referral		**General**		Primary		Overall		
Items	**n**	**n (%)**	**n**	n (%)	n	n (%)	n	n (%)	p-value
Dedicated space for KMC	21	20 (95)	51	35 (67)	126	88(70)	198	143(72)	0.04
KMC wraps	21	5 (24)	51	9 (18)	126	17(13)	198	31 (16)	0.44
Gowns for mothers	21	5 (24)	51	2 (4)	126	10(8)	198	17 (9)	0.02
TV for health education	21	7 (33)	51	2 (2)	126	7(6)	198	16 (8)	0.00
Reclining beds with curtains	22	16 (73)	56	28 (50)	130	62(48)	208	106 (51)	0.09
Comfortable chairs	22	7 (31)	56	6 (11)	129	16 (12)	207	29 (14)	0.04
Cabinets for mothers/bed side	22	9 (40)	56	15 (27)	130	19 (15)	208	43 (21)	0.01
Refrigerator	21	9 (43)	51	7 (14)	126	8 (6)	198	24 (12)	0.00
Room warmer	21	8 (38)	51	23 (45)	111	32 (29)	198	63 (34)	0.12
Food for mothers	21	16 (76)	45	21 (47)	111	25 (23)	177	62 (35)	0.00
Mean score		**43**		**26**		**15**		**25**	

4. Discussion

In Ethiopia, neonatal mortality remains high, indicating the urgent need for access to good quality care for all and specialized care for small and sick newborns [15,16]. Therefore, this study was conducted to assess the readiness of 208 public hospitals to provide care across the continuum from L&D wards to NCUs. There were significant deficits in readiness both in the L&D wards and NCUs, with an overall composite readiness score of 59% in L&D wards and 57% in NCUs. Significant variations in neonatal care readiness were observed across hospital levels, with the lowest readiness in primary hospitals.

Basic amenities in L&D wards and NCUs

Forty seven percent of the hospitals had key basic amenities for newborn care in the L&D wards, and this varied by hospital level, ranging from 68% in referral hospitals to 43% in primary hospitals. This contrasts with findings from Asia and Sub-Saharan Africa, where infrastructure was reported to be more consistently available [17]. WASH is essential for proper IPC practices in preventing neonatal infections; however, many hospitals lacked functional WASH facilities, which negatively affected the implementation of IPC measures [18,19]. Lack of an available water supply hampered hand hygiene, instrument cleaning, service delivery, and overall clinical safety [20]. This study showed that most hospitals, across all levels of care, lacked continuous water supplies in L&D wards and NCUs, thus contributing for poor hand hygiene practice and overall IPC measures. This finding is consistent with the Ethiopian service provision assessment, which reported that only about two-thirds of facilities had a continuous water supply, and these findings are supported by other studies [19–24].

In the current study, only half of the hospitals had uninterrupted electricity, with frequent and prolonged outages, particularly in primary hospitals. Such power disruptions can be can negatively affect sick and small newborns health care service, leading to severe neonatal health complications or death. Comparable findings have been reported in other studies in Ethiopia and in several other Sub-Saharan African countries, where power interruptions remain a persistent barrier to safe

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neonatal care [24–27,47]. In contrast, studies from South Asia, including Pakistan and India, showed more consistent electric power supply in higher-level hospitals, although rural and peripheral facilities continued to face challenges [28–30].

Readiness for essential newborn care and respiratory support

Regarding hospitals' readiness for essential newborn care, the mean domain-specific readiness scores indicated that about three-quarters of hospitals were well prepared. This was higher than what was seen in a multi-country study in Sub-Saharan Africa, where only about two-thirds of the hospitals were prepared for neonatal resuscitation, and was higher compared to a study showing that fewer than half of public health facilities in Afghanistan had essential supplies [14,17].

Hospitals are expected to have a dedicated space for neonatal resuscitation and to be fully equipped with essential devices and supplies [31]. In this study, although nearly 90% of the hospitals had designated functional resuscitation corners, none were fully equipped with the complete set of recommended devices and materials. This finding aligns with other studies from low- and middle-income countries and in a study done on the quality of neonatal resuscitation in Ethiopia showed that only half of health facilities were adequately prepared for neonatal resuscitation in terms of essential equipment [34,35]. Similarly, a facility audit in southern Nigeria reported significant gaps in basic resuscitation devices [36]. These gaps emphasize the need to equip health facilities with the basic devices needed to support newborns with respiratory problems and to improve neonatal outcomes.

Almost 10% of newborns and a large proportion of preterm infants cannot breathe spontaneously at birth and require bag-mask ventilation [37]. However, we found that basic equipment for bag-mask ventilation was lacking in half of the hospitals studied. This finding contrasts with studies from Kenya and Tanzania, which reported that more than 70% of hospitals had neonatal bags and masks [38,39].

The WHO recommends the use of bCPAP for preterm newborns with signs of RDS and for all infants born before 32 weeks of gestation [31]. Nearly 11% of newborns in Ethiopia are born preterm, and many require respiratory support with bCPAP to improve survival [40]. However, we found that only 14% of L&D wards and 35% of NCUs had either standard or improvised bCPAP machines. In contrast, the findings of Kenyan facilities reported that all surveyed hospitals had bCPAP devices, indicating a substantial disparity in the availability of this essential technology across clinical settings [42].

Readiness regarding amenities, equipment, and drugs in NCUs

Effective neonatal care in NCUs requires adequate equipment and supplies as well as skilled HCPs [17,45]. Our findings showed significant readiness gaps across all domains, with an overall readiness score of about 60%. Although two-thirds of hospitals had basic amenities, medicines, equipment, lab tests, and IPC supplies, only half had the required staffing and guidelines. Similar gaps in neonatal readiness have been reported in other studies conducted in Ethiopia, Nigeria, Tanzania, Uganda, and India, especially in lower-level hospitals [36,38,39,51].

Regarding the availability of equipment in NCUs, no facility had all the required basic equipment in NCUs, and overall, nearly two thirds of hospitals were well equipped with NCU beds, radiant warmers, room warmers, oxygen cylinders, portable electrical suction pumps, oxygen concentrators, digital thermometers, and pulse oximeters. These findings contrast with studies from Pakistan and Sub-Saharan Africa reporting higher levels of readiness [41]. Compared to another study from Ethiopia, where nearly one quarter of the hospitals met the standards, there has been some progress at higher levels, though overall preparedness remains suboptimal. In the current study, nearly two-thirds of hospitals had phototherapy machines and 92% had functional radiant warmers. In contrast, a study from Pakistan showed a higher phototherapy availability (91%) but lower warmer availability (70%) [32,40].

The availability of essential drugs is critical for managing infections and for saving sick newborns. However, our study identified significant gaps across hospitals, with none reporting the availability of all 16 assessed drugs, including antimicrobials, neurologic agents, inotropes, bronchodilators, corticosteroids, vitamin K, and IV infusions at the time of the study. These findings

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are consistent with studies from Pakistan and Ethiopia [41,50]. Approximately four-fifths of hospitals had first-line antimicrobials, including ampicillin, gentamicin, and cloxacillin. However, second-line drugs such as ceftriaxone, ceftazidime, ciprofloxacin, IV azithromycin, and vancomycin were available in only 33–54% of hospitals. Similar shortages have been reported in the findings from studies in Kenya and India, indicating widespread challenges in ensuring access to essential medications for newborns [42,43].

Regarding the readiness of hospitals to perform laboratory investigations, our findings showed that two third of the hospitals had basic laboratory services. Readiness levels varied by facility type, ranging from 74% in referral hospitals to 58% in primary hospitals. The readiness of primary hospitals in our study was comparable to findings from similar study done on the readiness of primary hospitals in providing neonatal intensive care services in Ethiopia, which reported 65% readiness for different laboratory services. Similar trends were also observed in studies conducted across Asia and Sub-Saharan Africa [31,41].

KMC

Despite the WHO's strong recommendation of KMC for preterm and LBW infants and the need for adequate infrastructure and resources [33,44,45], most hospitals in our study showed low readiness. Only three-quarters had dedicated KMC rooms, and just a quarter of hospitals were equipped with essential materials and supplies for KMC. Similar gaps have been reported in other Ethiopian studies [41,47,48,51].

Human resources

Trained nurses were available in nearly all studied hospitals, indicating relatively greater readiness compared to another Ethiopian study, where only 65% of hospitals had trained neonatal HCPs [16]. Despite overall staffing shortages, this suggests the increased availability of trained nurses in NCUs.

Paediatricians play a key role in neonatal care and help train and guide other staff. However, in our study fewer than half of the hospitals had paediatricians on their staffing, with most being based in referral hospitals, which contrasts with findings from Pakistan, where all hospitals reported having paediatricians, [17] and aligns with another Ethiopian study on health system readiness for preterm, LBW, and sick newborn care [44].

Infection prevention and control

Evidence indicates that effective IPC measures can reduce healthcare-associated infections by up to 55%, and newborn survival rates can potentially increase by 44% when hand washing and clean birthing kits are in place [20]. The WHO recommends that all health facilities should follow minimum IPC standards at the point of care, including continuous water supply, hand hygiene supplies, disinfectants, proper waste management, and adequate space for IPC practices [51]. However, only about 70% of the hospitals in this study had the necessary IPC supplies. Furthermore, only about half of the hospitals had functional handwashing facilities and only around 75% had essential antiseptics and disinfectants. These findings align with a WHO multi-country assessment showing that, despite the availability of basic IPC supplies, infrastructural limitations limited their use in neonatal care settings [24,51].

5. Conclusions

Despite improvements in recent years, we found many gaps in critical readiness domains in L&D wards and NCUs. The government and partners along with other stakeholders must collaborate to ensure the consistent availability of sufficient amenities, equipment, essential diagnostic and treatment commodities, staffing, and guidelines for high-quality newborn care at all hospital levels.

Moreover, we highly recommend regular readiness assessments of hospitals for neonatal care to ensure early gap identification and evidence-based solutions to enhance the quality of newborn care and thus improve survival outcome for preterm and LBW infants.

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Informed Consent Statement: Each hospital leader and the responsible heads of the relevant hospital units—including the NCUs, L&D wards, pharmacy, and laboratory units—were provided with a support letter from the respective Regional Health Bureaus, along with a copy of the ethical clearance letter from the AAU Institutional Review Board (IRB). Informed consent was requested and obtained from all participants prior to conducting the interviews. Interviews were carried out in settings that ensured both auditory and visual privacy. All data were kept confidential and were accessible only to members of the study team.

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Abbreviations

bCPAP	Bubble continuous positive airway pressure
HCPs	Health care providers
IPC	Infection prevention and control
KMC	Kangaroo Mother Care
LBW	Low birth weight
L&D	Labour and delivery
NCUs	Neonatal care units
SARA	Service Availability Readiness Assessment
SLL	Saving Little Lives
WASH	Water, sanitation, and hygiene

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