Healthcare utilization by children with neurological impairments and disabilities in rural Kenya: a retrospective cohort study combined with secondary analysis of audit data

Jonathan Abuga1,2*, Lucy Mwangi1*, Joyce Ndolo3, Symon Kariuki1,4, Charles Newton1,4

1Clinical Research (Neurosciences), KEMRI-Wellcome Trust Research Programme, Kilifi, Kilifi, Po Box 230-80108, Kenya
2Public Health Department, Kisii University, Kisii, Kisii, Po Box 408-40200, Kenya
3Occupational Therapy Department, Kilifi County Hospital, Kilifi, Kilifi, Po Box 9-80108, Kenya
4Department of Psychiatry, University of Oxford, Oxford, Oxford, OX3 7JX, UK

* Equal contributors

Abstract

Background: There is a paucity of data on healthcare utilization by children with neurological impairments (NI) in sub-Saharan Africa. We determined the rate, risk factors, causes, and outcomes of hospital admission and utilization patterns for rehabilitative care among children with NI in a defined rural area in Kenya.

Methods: We designed two sub-studies to address the primary objectives. Firstly, we retrospectively observed 251 children aged 6–9 years with NI and 2162 age-matched controls to determine the rate, causes and outcomes of hospitalization in a local referral hospital. The two cohorts were identified from an epidemiological survey conducted in 2015 in a defined geographical area. Secondly, we reviewed hospital records to characterize utilization patterns for rehabilitative care.

Results: Thirty-four in-patient admissions occurred in 8503 person-years of observation (PYO), yielding a crude rate of 400 admissions per 100 000 PYO (95% confidence interval (CI): 286–560). The risk of admission was similar between cases and controls (rate ratio=0.70, 95%CI: 0.10–2.30, p = 0.31). The presence of electricity in the household was associated with reduced odds of admission (odds ratio=0.32, 95% CI: 0.10–0.90, p < 0.01). Seizures and malaria were the main causes of admission. We confirmed six (0.3%) deaths during the follow-up period. Over 93% of outpatient paediatric visits for rehabilitative care were related to cerebral palsy and intellectual
developmental delay. Health education (87%), rehabilitative exercises (79%) and assistive technology (64%) were the most common interventions.

Conclusions: Surprisingly, the risk of hospitalization was not different between children with NI and those without, possibly because those with severe NI who died before this follow-up were under seclusion and restraint in the community. Evidence-based and tailored rehabilitative interventions are urgently required based on the existing secondary data.

Keywords
Children; neurological impairments and disability; hospitalization; admission; healthcare; rehabilitation; Kenya; LMICs.
Introduction

Over 300 million children and adolescents have some form of neurological impairment or disability (NI), which accounts for 19.9% of the years lived with disability (YLD) from all causes in these age-groups globally (Oluusanya et al., 2020). The prevalence is higher in low- and middle-income countries (LMICs) due to a higher incidence of risk factors such as adverse perinatal events (Kumar et al., 2013; Mung’ala-Odera et al., 2006), infections of the brain (Abubakar et al., 2009; Carter et al., 2005; Kariuki et al., 2011), malnutrition (Asfaw et al., 2017; Roncaglio et al., 1998) and socio-economic disadvantage (Banks et al., 2017). Affected children from LMICs are unlikely to access regular preventive, curative, and rehabilitative care due to societal stigma, high user-fee costs, geographical barriers, and poorly funded healthcare systems (Ensor & Cooper, 2004; Mwangi et al., 2021a; WHO, 2011). Reducing the overall burden, including adverse social outcomes, related to NI largely depends on the quality and coverage of primary healthcare.

Current scientific evidence from high-income countries (HICs) suggests that children with NI have additional healthcare needs compared to their peers without NI (Meehan et al., 2015; Yuan et al., 2017). A study conducted in the United States reported that children with seizures, traumatic brain injury, and meningitis had three times greater use of intensive care unit services, with a significantly longer hospital stay, than other paediatric patients at the initial events (Moreau et al., 2013). Similarly, children with cerebral palsy received more medical procedures and had a higher probability of referral or recommendation for homecare (Murphy et al., 2006). Respiratory, musculoskeletal, and digestive problems were the most common causes of admission in these studies (Moreau et al., 2013; Murphy et al., 2006). There is a scarcity of empirical evidence on patterns of promotive, preventive, curative and rehabilitative care for children with NI in LMICs.

Rehabilitation services are critical for children with NI in terms of reducing activity limitations, enhancing community participation, improving quality of life, and ultimately increasing the chances of survival (WHO, 2011; WHO, 2018). However, there is an acute shortage in coverage and capacity for rehabilitative care in LMICs (Bright et al., 2018; Bunning et al., 2014; Njelesani et al., 2011). For instance, between 5–15% of people with NI need assistive devices, yet insufficient resources are currently available to acquire these devices in LMICs (WHO, 2011). Further, for every 100 000 people residing in sub-Saharan Africa (SSA), on average, there is less than one rehabilitation doctor (Haig et al., 2009), less than one psychologist (Saxena et al., 2007), less than one ophthalmologist (Resnikoff et al., 2020), and less than one neurologist (WHO, 2018) to consult for rehabilitation needs of the affected children. The World Federation of Occupational Therapists reports that most countries in SSA do not meet the recommended international average ratio of two Occupational Therapists for every 10 000 people (WFOT, 2020).

The International Classification of Functioning, Disability and Health (ICF) defines NI as deficits in the structure or functioning of the central nervous system consequent to a disease (WHO, 2001). It also provides a common language and framework for the care and research involving children with NI and disabilities, globally. Healthcare coordination for children with NI and disabilities is largely understudied in LMICs (Peterson et al., 2019). Based on the Donabedian model (Donabedian, 2005), healthcare coordination for children with NI will involve three closely related concepts: (i) structures, for example, the presence of trained personnel, availability of appropriate facilities/equipment and payment options for the care of children with NI; (ii) processes, for instance, the coordination and referral processes which promotes utilization of preventive, curative and/or rehabilitative services for these children; and (iii) outcomes of care such as recovery, permanent disability or even death (McDonald et al., 2007).

This study had three main objectives that targeted children with NI in a defined rural setting in Kenya. First, we estimated the rate of in-patient admissions to a local referral hospital between 2015 and 2019 among older children diagnosed with NI compared to an age-matched sample of controls identified from the same baseline survey conducted in 2015. Secondly, we identified the causes and outcomes of in-patient admissions of children with NI compared with those without NI. Finally, we describe utilization patterns for rehabilitative care by children younger than 19 years visiting the physiotherapy, occupational therapy, and orthopaedic technology departments of the same regional referral hospital over the same period.

Methods

Study setting

We conducted this study in the Kilifi Health and Demographic Surveillance System (KHDSS) located around Kilifi County (district) Hospital (KCH) in Kenya (https://kemri-wellcome.org/programme/health-research-linked-to-a-demographic-surveillance-system/). Since 2001, this integrated surveillance system linking laboratory, clinical and community-based research platforms has been used to define the incidence and prevalence of common infections such as malaria, behavioural/emotional problems and epilepsy in a population of about 280 000 individuals (Scott et al., 2012). Vital statistics such as births, migrations, and deaths are updated two to three times a year based on a household census (Scott et al., 2012). Children younger than 15 years constitute approximately half of the population under surveillance (Scott et al., 2012). KCH offers rehabilitative services across three departments, namely physiotherapy, occupational therapy, and orthopaedic technology (Bunning et al., 2014). The defined geographical area is among the poorest in Kenya, with subsistence farming being the main economic activity in this rural setting.

Study design

We designed two sub-studies to address the primary objectives of this study. The first sub-study was a retrospective cohort design involving a follow-up of children who previously participated in a two-phase epidemiological survey conducted in 2015 (Figure 1). The second sub-study entailed an analysis of audit data obtained from routine care in three rehabilitative departments in Kilifi County Hospital, details which we provide below.
The retrospective cohort analyses of survey data (first sub-study)

Identification of study participants from the baseline survey (Figure 1): We identified participants for the cohort study from a two-phase epidemiological survey, initially designed to determine the prevalence and risk factors for NI in children aged 6–9 years in 2015 (Abuga et al., 2022). A random sample of 11,223 eligible children, out of the total population of 37,294 (30.1%), was screened in the households by trained field workers in the community using the Ten Question Questionnaire (TQQ) (Belmont, 1984; Durkin et al., 1995; Zaman et al., 1990) in stage one of the 2015 baseline survey. In stage two, all children screening positive on the TQQ, and a random sample that screened negative were invited for comprehensive neuropsychological assessments conducted by neurodevelopmental experts using pretested and validated tools (Kitsao-Wekulo et al., 2019; Mung’ala-Odera et al., 2006; Thurman et al., 2011; WHO, 2011). In this survey, we defined NI as a central nervous system deficit resulting in functional limitation in five domains: epilepsy and cognitive, hearing, vision, and motor impairments. The severity of NI was classified as mild, moderate, or severe based on the World Health Organization’s (WHO) recommendations. We also assessed potential risk factors for NI and subsequent hospitalization in the baseline survey. We collected individual-level data on age, sex, school attendance, and family-level information such as the mother’s education and income, as well as past medical history including unique events during pregnancy and birth, head injuries, immunization and anthropometric measures of nutritional status.

Sample size determination for the cohort sub-study: Assuming that NI cases have a two-fold increased risk of in-patient hospital admission compared with controls (Glover et al., 2019; Lee & Chen, 2012), and the rate of admission is 13.1%
among cases (Lee & Chen, 2012), a cohort study of independent cases matched to 5 controls requires 79 cases and 395 control cases to reject the null hypothesis that the relative risk of hospitalization equals one with 80% power at 95% confidence level (CI). Therefore, our study with 251 cases (children diagnosed with at least one NI in the five domains) and 2162 randomly selected age-matched controls was sufficiently powered to detect differences in the risk of admission between the groups.

Methods of follow-up. This retrospective cohort study utilized data linkage between the 2015 NI survey’s database and the KCH paediatric admissions database, and between the 2015 NI survey’s database and the general KHDSS databases to determine the primary and secondary outcomes, respectively. The primary outcome of the follow-up study was admission to the paediatric department at KCH. The secondary outcome was the number of deaths occurring among the study participants during the follow-up period. Unique personal identification numbers (PIDs) are usually assigned to all study participants in the KHDSS [including all children participating in surveys and those admitted to the paediatric wards in KCH] for follow-up studies (Scott et al., 2012). We linked the 2015 NI baseline survey’s database with the hospital’s paediatric in-patient database and the KHDSS databases using these unique identifiers to determine the number of admissions and deaths, respectively. The primary and secondary outcome events were restricted within the study period which was between 30th June 2015 and 30th June 2019. Cases and controls from the baseline survey entered the risk pool on their respective dates of the household survey in 2015 and exited at the end of the follow-up study (30th June 2019), or the date of hospital admission, out-migration, or death; whichever came first. We linked all available cases and age-matched controls using the PIDs with the two databases to prevent bias due to incomplete data linkage.

Analysis of audit data on rehabilitative care (second sub-study) It was not possible to link the 2015 NI survey participants to the rehabilitative departments at KCH because (i) comprehensive patient-level data were unavailable in these departments, and (ii) in-patient hospital visits to these departments are not linked to the KHDSS. Consequently, we could only conduct a secondary analysis of routine medical-care data characterizing rehabilitative services utilized by children younger than 19 years visiting the occupational therapy, physiotherapy, and orthopaedic technology departments between January 2015 and December 2019. We retrieved information on the number of visits per month, diagnostic categories issued by attending clinicians/specialists, and the interventions offered by these departments. We considered six main diagnostic categories namely: cerebral palsy (CP), intellectual developmental delay (IDD), epilepsy, hearing disorders, vision disorders, and learning disorders. CP was defined as a group of permanent motor disorders that appear early in childhood caused by abnormal brain development (Blair et al., 2001). IDD referred to the failure of a child to reach one or more expected developmental stages at the expected age (Choo et al., 2019). Learning disorders described difficulties in processing and comprehension of information at home or school (Komm, 2009). We compared summary data obtained from compiled monthly reports with that retrieved from available patient registers for consistency. Health education, in this context, referred to a structured or semi-structured session between the attending occupational therapist or physiotherapist and the caregivers of children with NI, aimed at providing additional support information for the care of the affected child. Passive exercises refer to selected techniques such as muscle stretching usually performed on patients by physiotherapists (Pin et al., 2006).

Statistical analyses for the two sub-studies We exported linked retrospective data on paediatric in-patient admissions and secondary data on rehabilitative care from the hospital to Stata version 14 (StataCorp, 2015). Missing data due to incomplete data linkage was minimal (<2%) and therefore we analysed all completely linked data. We determined the rates for in-patient admission for NI cases and controls separately, with the numerator being the number of admissions and the denominator person-years of observation (PYO), using the linked retrospective data. We then calculated the admission rates ratio (RR) and their 95% confidence intervals (95% CI) to compare admission rates for the two groups. We also determined and compared the number of deaths among children with and without NI over the follow-up period. Potential independent predictors for hospital admission included child and family characteristics, and the medical history of the child which were initially assessed in the baseline survey. We used binary logistic regression in risk factor analysis for in-patient admissions and estimated odds ratios (OR) and their 95% CI. For the second sub-study, we analysed the frequency of outpatient visits and the interventions offered for each diagnostic category in the three rehabilitative departments in KCH between 2015 and 2019.

Ethical considerations We obtained approval for this study from the KEMRI/Scientific and Ethics Review Unit (Ref: KEMRI/SERU/CGMRC-C/ 125/3701). We sought written consent from the parents/guardians/caretakers of the study participants before data collection in the baseline survey and the cohort study. We obtained permission to conduct an audit of the files from the hospital administration, which was accompanied by an approved protocol by a peer review committee. All secondary data was de-identified or anonymised by stripping off all the identifying features before analyses. All data were kept confidential and anonymous.

Results The retrospective cohort analysis of survey data (first sub-study) A total of two hundred fifty-one children aged between 6–9 years with NI, of whom 137 (54.6%) were boys, were identified in the 2015 baseline survey and followed up until 2019 (Table 1). Similarly, 2162 boys and girls without NI were identified from...
the same survey in 2015 and followed up until 2019 (Table 1). Two hundred and fifty out of 251 (99.6%) cases and 2149 (99.4%) out of 2162 controls completed the follow-up study. The median (range) follow-up duration was 3.8 years (interquartile range [IQR] = 3.4–4.2) and 4.0 years (IQR = 3.4–4.8) for cases and controls, respectively. The proportions lost to follow up for cases (0.4%) and controls (0.3%) were not significantly different ($p = 0.10$). Study participants lost to follow-up, who were excluded from the main analyses, were similar to those completing the study in terms of sex ($p = 0.23$) and age ($p = 0.24$). There were no differences in proportions comparing cases and controls at the baseline of the cohort study in terms of sex ($p = 0.50$) and age ($p = 0.93$); however, cognition and epilepsy domains were overrepresented in the sample of cases (Table 1). The full dataset can be accessed upon request under Underlying data (Mwangi et al., 2021b).

A total of 34 in-patient hospital admissions occurred in 8503 person-years of observation (PYO), yielding a crude admission rate of 400 per 100 000 PYO (95% CI: 286–560). Of these admissions, three (1.2%) were cases of NI and 31 (1.6%) age-matched controls. Among cases, the admission rate was 294 per 100 000 PYO (95% CI: 95–911) and 414 per 100 000 PYO (95% CI: 291–589) among controls. There was no significant difference in hospital admission rates comparing cases and controls (RR = 0.70, 95% CI: 0.10–2.30, $p = 0.31$). Six (0.3%) deaths, two (<0.1%) among cases and four (<0.1%) among controls, were confirmed in the follow-up study.

Having electricity in the household was associated with a 68% reduction in the risk of hospital admission (univariable OR = 0.32, 95% CI: 0.1–0.9, $p = 0.03$). However, the sex of the child, maternal education, income-generating activity, medical history, and nutritional status at the study baseline were not associated with hospital admission at the univariable level (Table 2). Three leading causes of admission regardless of NI status were malaria with 10 (29.4%) cases, trauma or fractures with five (14.7%) cases, and snake bites with four (12.9%) cases (Table 3). Two of the three children with NI were admitted because of epileptic seizures while one child had malaria.

### Analysis of audit data on rehabilitative care (second sub-study)

A total of 14 765 visits by children aged 0–18 years were recorded in the occupational therapy department between 2015 and 2019, of which 7 005 (47.4%) and 6 773 (45.8%) were related to CP and IDD diagnoses, respectively. Fewer visits were related to hearing disorders ($n = 710$, 4.8%), learning disorders...
(n = 214, 1.4%), vision disorders (n = 58, 0.4%), and epilepsy (n = 5, <0.10%). The number of visits related to CP and IDD increased by 36.8% and 62.2% between 2015 and 2019, respectively, while those related to hearing disorders had a three-fold increase (Table 4). The highest number of visits by patients with learning and vision disorders was recorded between 2016 and 2017. A total of 78 146 health education sessions, 5,896 treatment sessions for physical disability, 4,896 community rehabilitation sessions, and 1,180 splints were provided over the study period in this department (Table 4).

A total of 704 visits by NI patients younger than 10 years were recorded in the physiotherapy department between 2015 and 2019, of which 546 (77.6%) were related to CP (Table 5). The highest number of CP, IDD, and epilepsy-related visits were recorded in 2015 and 2016. Over the study period, interventions in this department included 518 rehabilitation exercises, 135 passive exercises, and three chest treatments. Chest physiotherapy and postural drainage were rare interventions in this department (Table 5).

A total of 617 visits were recorded mainly from children younger than 19 years with CP in the orthopaedic technology department. An average of 152 visits per annum (VPA) was recorded in 2018–2019 compared with 104 VPA between 2015 and 2017. Only three visits were related to epilepsy, one in

### Table 3. Causes of in-patient admission for cases and controls of neurological impairment followed-up between 2015 and 2019 in Kilifi Health and Demographic Surveillance System in Kenya.

<table>
<thead>
<tr>
<th>Causes of admission</th>
<th>Cases (%)</th>
<th>Controls (%)</th>
<th>All admissions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>1 (33.3)</td>
<td>9 (29.0)</td>
<td>10 (29.4)</td>
</tr>
<tr>
<td>Trauma/ fracture</td>
<td>0</td>
<td>5 (16.1)</td>
<td>5 (14.7)</td>
</tr>
<tr>
<td>Snakebites</td>
<td>0</td>
<td>4 (12.9)</td>
<td>4 (12.9)</td>
</tr>
<tr>
<td>Upper respiratory infection</td>
<td>0</td>
<td>2 (6.5)</td>
<td>2 (5.9)</td>
</tr>
<tr>
<td>Seizures</td>
<td>2 (66.7)</td>
<td>0</td>
<td>2 (5.9)</td>
</tr>
<tr>
<td>Others causes†</td>
<td>0</td>
<td>11 (35.5)</td>
<td>11 (32.4)</td>
</tr>
<tr>
<td>Total</td>
<td>3 (100)</td>
<td>31 (100)</td>
<td>34 (100)</td>
</tr>
</tbody>
</table>

†Others causes include meningitis, anaemia, accidents, lower respiratory infection, gastroenteritis, neonatal jaundice, cellulitis, measles, malnutrition, elective surgery, bronchitis.

### Table 4. Number of visits and interventions by Kilifi County Hospital’s Occupational Therapy Department for children aged 0–18 years with neurological impairments between 2015 and 2019.

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostic category (domain)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>1102</td>
<td>1303</td>
<td>1594</td>
<td>1498</td>
<td>1508</td>
<td>7005</td>
</tr>
<tr>
<td>Intellectual developmental delay</td>
<td>1057</td>
<td>1216</td>
<td>1236</td>
<td>1550</td>
<td>1714</td>
<td>6773</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Hearing disorders</td>
<td>50</td>
<td>98</td>
<td>160</td>
<td>193</td>
<td>209</td>
<td>710</td>
</tr>
<tr>
<td>Learning disorders</td>
<td>-</td>
<td>162</td>
<td>3</td>
<td>20</td>
<td>29</td>
<td>214</td>
</tr>
<tr>
<td>Vision disorders</td>
<td>1</td>
<td>1</td>
<td>46</td>
<td>3</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td><strong>Interventions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of health education sessions</td>
<td>6055</td>
<td>7330</td>
<td>18980</td>
<td>14950</td>
<td>20416</td>
<td>78146</td>
</tr>
<tr>
<td>Number of treatment sessions for those with physical disability</td>
<td>775</td>
<td>1190</td>
<td>749</td>
<td>1305</td>
<td>1840</td>
<td>5859</td>
</tr>
<tr>
<td>Number of community rehabilitation sessions</td>
<td>-</td>
<td>328</td>
<td>698</td>
<td>460</td>
<td>3410</td>
<td>4896</td>
</tr>
<tr>
<td>Number of splints</td>
<td>4</td>
<td>257</td>
<td>204</td>
<td>245</td>
<td>470</td>
<td>1180</td>
</tr>
</tbody>
</table>
2015 and two in 2016. A total of 416 assistive devices, 153 knee ankle-foot orthoses, 53 lumbar corsets, and 19 neck collars were fabricated for these children. Ankle foot orthoses (n = 6), hand splints (n = 2), and surgery (n = 1) were less frequent interventions in this department.

**Discussion**

There was no significant difference in the rate of paediatric in-patient admission between children with NI and those without (IRR = 0.70, 95% CI: 0.10–2.30, \( p = 0.31 \)). The presence of electricity in the household was associated with a 68% reduction in the odds of hospital admission. Overall, the three leading causes of admission were malaria (29%), trauma/fractures (15%), and snakebites (13%). Epilepsy and malaria were the main causes of admission among children with NI. Few deaths were confirmed among children with NI and those without during the study’s follow-up period. About half of the visits for rehabilitative care were related to CP, while 44% of visits were related to IDD. Rehabilitative exercises, assistive devices, and health education sessions were the three rehabilitative departments’ most common forms of therapy.

The risk of in-patient hospital admission was similar for NI cases and controls, contrary to a study in the US where the risk was much higher among cases than controls [16.9% versus 0.2%] (Berry et al., 2012). Children with severe NI, such as non-ambulatory cases with CP, have recorded far higher admission rates than children of the same age group from the general populations in HICs (Carter et al., 2021; Meehan et al., 2015; Yuan et al., 2017). Children with severe NI in LMICs might not survive into late childhood which might explain the low rate of hospitalization among the cases. The few deaths observed during the follow-up might not explain the similarity of in-patient hospital admissions compared to children with and without NI. The duration of follow-up in our study was short and perhaps long-term survival studies (Abuga et al., 2019) among younger children might indicate a difference in future studies. It is also plausible that children with NI are marginalized, secluded, and restrained in their communities, and might lack access to formal healthcare due to social, financial, and geographic barriers, as is the case in many LMICs (Mwangi et al., 2021a; Zuurmond et al., 2019). Besides, some children (~23%) whose care providers did not seek formal healthcare (Ngugi et al., 2017), were missed from this analysis, underestimating the risk of hospitalization of children with NI. Contrary to studies from HICs, which have established that children with NI experience more frequent hospitalization (Moreau et al., 2013), inadequate data on premature mortality in younger age groups and gaps in the provision of healthcare prevent the ascertainment of the actual risk of hospitalization in LMICs.

A higher socio-economic status in the community might imply better health status and therefore fewer hospital admissions. The presence of electricity in the household, which might be an indicator of higher socioeconomic status, was associated with decreased risk of hospitalization. Abdullahi and others (Abdullahi et al., 2020) have previously shown that poverty is associated with an increased risk of hospitalization of children with NI. Poverty is an underlying risk factor for disease and disability which manifests itself as families’ inability to address one or more direct risk factors such as food security, hygiene/sanitation, or access to healthcare. Maternal characteristics such as education and income and past medical history were not associated with seeking hospital care. This contrasts with the knowledge that incomplete immunization and malnutrition weaken children’s immunity increasing susceptibility to acute infections and the possibility of hospitalization (Prendergast, 2015).

Overall, the main causes of admission in this study were malaria, accident-related trauma/fractures, and snakebites. Malaria remains an important cause of hospitalization accounting for over 30% of all admissions among children in Kenya.

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**Table 5. Number of visits and interventions by Kilifi County Hospital’s Physiotherapy Department for children aged 0–10 years with neurological impairments between 2015 and 2019.**

<table>
<thead>
<tr>
<th>Year of study</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic category (domain)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>182</td>
<td>77</td>
<td>59</td>
<td>112</td>
<td>116</td>
<td>546</td>
</tr>
<tr>
<td>Intellectual developmental delay</td>
<td>34</td>
<td>35</td>
<td>15</td>
<td>15</td>
<td>23</td>
<td>122</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>11</td>
<td>7</td>
<td>1</td>
<td>9</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>Interventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of rehabilitation exercise sessions</td>
<td>179</td>
<td>75</td>
<td>69</td>
<td>99</td>
<td>96</td>
<td>518</td>
</tr>
<tr>
<td>Number of passive exercise sessions</td>
<td>13</td>
<td>18</td>
<td>21</td>
<td>46</td>
<td>37</td>
<td>135</td>
</tr>
<tr>
<td>Chest therapy</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Postural drainage</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
Evidence from Mali indicates that almost half of paediatric hospital admissions are related to malaria and trauma mainly from road/traffic accidents (Campbell et al., 2004). Acute seizures, the main cause of admissions among children with NI in the study area, are likely related to malaria (Bistervels et al., 2016; Kariuki et al., 2011). A study conducted in the defined rural area also established that epilepsy is an important cause of hospitalization which concurs with our findings (Kariuki et al., 2015).

Most patient visits to the rehabilitation departments were related to CP perhaps due to the gross physical and functional incapacity associated with the condition. The number of visits per diagnostic category was related to the nature of services offered by these departments. Some children may have been seen at a separate epilepsy clinic affiliated with the hospital (Ibinda et al., 2014), which explains the low number of epilepsy-related visits to the rehabilitation departments. In 2019, this epilepsy clinic recorded 728 child visits of whom 60% were diagnosed with epilepsy and over 98% were on anti-seizure medications, mainly carbamazepine, phenobarbital, and sodium valproate. This epilepsy clinic has regularized online prospective capture of patient visits, a coordinated data capture process we recommend in the rehabilitation departments.

The number of visits to the orthopaedic and physiotherapy departments decreased from 2015 to 2019; whereas visits related to CP, IDD, and hearing disorders in the occupational therapy department increased. The prolonged healthcare workers’ strike in 2017 affected the delivery of services across the three departments (Waithaka et al., 2020). Additionally, the observed trends might be explained by trends in rehabilitation promotion activities/or referrals from other hospital departments and the catchment community. We hypothesize that other private or non-governmental organizations outside the formal healthcare system might be offering some form of healthcare and/or rehabilitation for children with NI in the study area. There is a need to map out such organizations to determine the unmet need and gaps for planning and quality improvement of all available rehabilitation services within the study area.

Evidence-based interventions were lacking in the rehabilitative departments, and therefore, limited access to adequate rehabilitative care to improve quality of life, reduce activity limitation, increase community participation, as well as increase chances of survival (WHO, 2011; WHO, 2018). The type of orthopaedic technology offered in the rehabilitation clinics such as knee-ankle-foot orthoses, lumbar supports, and neck collars, and the relatively few ankle-foot-orthoses, is quite different from what is commonly utilized in HICs. There is limited evidence on the effectiveness of passive exercises (Pin et al., 2006), which were fairly often utilized in this hospital. The low quality of rehabilitative care typified by a lack of evidence-based interventions in this setting might highlight the need to lobby for adequate resources and training or development of local capacity.

A previous study (Bunning et al., 2014) has shown that these departments usually focus on physical dysfunction and little attention is given to cognition and sensory needs among other specific needs such as adaptive skills training (Aydin et al., 2016; Choo et al., 2019; Wu et al., 2011; Zwier et al., 2010). The absence of comprehensive and need-based rehabilitation is also a major limitation in the few existing rehabilitative facilities in Kenya. Community-based rehabilitative services have been recommended by Kenya’s Association of the Physically Disabled (APDK) in collaboration with the Kenyan Ministry of Health, which is reaching out to persons with disabilities (WHO, 2010). Health promotion combined with community outreach is essential to address a dearth of information about the existence and importance of rehabilitative services in hospitals and communities (Iemmi et al., 2016).

To the best of our knowledge, this is the first study to investigate the rate of admissions among children with NI compared to controls and to describe utilization patterns for rehabilitative care in LMICs using audit data. However, our readers should consider the following study limitations. First, we possibly underestimated the risk of hospitalization because we could not adequately determine the hospitalization status of all cases and controls in the cohort study. Besides, this study did not consider those children seeking outpatient care in peripheral clinics. Secondly, there is a potential for residual confounding from unmeasured and changing risk factors for admissions during the follow-up period, e.g., nutritional status, since we measured the risk factors at the baseline of the cohort study. Third, there were several limitations to using audit data to investigate rehabilitative care for children with NI. The occupational therapy department recorded more patients because it had more therapists and received more children (0–19 years) as opposed to the physiotherapy department which mostly received older children (>10 years) and adults. Personal and family-related information was incomplete and, therefore, disaggregated analysis was not possible. Community and hospital-based quantitative and qualitative studies are required to identify barriers/facilitators to access and utilization of rehabilitative care to guide the design and implementation of effective and evidence-based interventions in LMICs. Also, our readers should consider the differences in the health and social care systems for children with NI and disabilities when comparing our data with evidence from HICs.

Conclusions
In summary, the current study did not identify a difference in the rate of hospitalization comparing children with and those without NI. Overall, malaria and accidents were important causes of hospital admission, and seizures were the main cause of admission for children with NI. Most visits for rehabilitative care in three child clinics were related to cerebral palsy and intellectual developmental delay. Rehabilitative exercises, assistive devices, and health education were the most common interventions offered by rehabilitative clinics.

Disclaimer
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Data availability

Underlying data


This project contains the following underlying data:
- Admission_data.csv
- Inpatient_data.do
- LucyM_Codebook.xlsx
- LucyM_ReadMe.txt
- Occupational_therapy.tab
- Orthopedics_2017-2019.tab
- Orthopedics_do_file.do
- orthopedics_therapy_2015-2017.tab
- OT16_2_Preliminary_results.do
- Physiotherapy.tab

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

References
