**Title**: **A Cross-sectional Study of the Clinical Profile of Children with Cerebral Palsy in Benin, a West-African Low-income Country.**

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**Abstract**

Cerebral palsy (CP) is a common cause of paediatric motor disability. While there are increasing data on the clinical profile of children with CP in High-Income Countries, corresponding information about Low-Income Countries (LIC) and developing countries is lacking. We aim to describe the clinical spectrum of CP in children in Benin, a representative West-African low-income country. Our cross-sectional observational study included 114 children with CP recruited from community-based rehabilitation centres and teaching hospitals (median age [range]: 7 [2; 17]; sex: 66% male). Data were collected through review of medical records and interviews with children’s mothers. Assessment included risk factors, clinical subtypes according to the Surveillance of CP in Europe, severity of motor outcome to scoring with the Gross Motor Function Classification System (GMFCS) and Manual Ability Classification System (MACS), comorbidities and schooling. We recorded a high prevalence of intrapartum adverse events. Seventeen percent of children had post-neonatal CP with cerebral malaria as the most common cause. Most of the children were severely affected (67.5% as bilateral spastic; 54.4% as GMFCS\_IV\_V), which substantially improved with age. Only 23% of the children with CP had attended school. Poor motor outcomes and comorbidities were associated with school non-attendance. These results suggest that intrapartum risk factors and post-natal cerebral malaria in infants are opportune targets for prevention of CP in Sub-Saharan LICs.

**Key words:** Cerebral palsy, cerebral malaria, Low-Income Country, Sub-Saharan Africa, epidemiology.

**Introduction**

Cerebral palsy (CP) is the most common cause of paediatric motor disability.1 The broad term describes a group of disorders impairing the development of movement and posture due to a non-progressive injury of the immature brain. Accompanying comorbidities of CP can include epilepsy, and impairments of sensation, communication and musculoskeletal functions.1

There are increasing amounts of data on the clinical profiles of children with CP in High-Income Countries (HICs) obtained through large population-based studies monitoring cases of CP in HICs, there remains a relative paucity of corresponding from Low and Middle Income Countries (LMICs).2, 3 The prevalence of CP is generally estimated at 2 – 2.5 per 1000 of birth survivors in HICs, and recent studies have shown a trend to decreasing incidence.4-6 The most reported risk factors for CP in HICs are prematurity and low birth weight.5, 6 There have hitherto been three population-based studies of CP in Africa, reporting prevalences of 2.7 per 1000 children in Uganda, and 2.04 and 3.6 per 1000 children in two different Egyptian districts.7-9 In West Africa, the clinical profile of CP is best described in Nigeria, which is a Middle-Income Country.3, 10, 11 Most of the Nigerian studies were conducted in tertiary paediatric clinics, and emphasized a description of motor outcomes, comorbidities and risk factors.10-12 Severe cases of CP with bilateral spastic CP and levels IV\_V of the Gross Motor Function Classification System (GMFCS) were predominant in the different studies. Risk factors differed from those in HICs, with respect to a larger percentage of factors such as birth asphyxia, kernicterus, and neonatal infections.3, 10-12

In the present study, we describe the clinical profile of children with CP in Benin, a Low-Income Country (LIC) in West Africa. Despite its LIC designation, community-based rehabilitation (CBR) is well developed in Benin. By training parents as therapists, CBR allows free access to rehabilitative care for children of parents unable to afford hospital-based care.13 This program is organized by the community itself and thereby is intended to promote social integration of children with disability. Thus, implementation of CBR should help to lower the risk of stigmatizing children with disability and their parents.13, 14 Financial impediments for most parents in seeking medical care, together with stigmatization, are factors likely to induce biases in hospital-based studies conduction in LMICs such as Benin.15 Indeed, such factors might bring about overrepresentation of high need children whose parents possess sufficient financial resources to obtain medical care.15 CBR settings, by offering free rehabilitation care, should help to lower this risk of bias.

This study aims to fill in the gaps in understanding CP in a West-African LIC by describing the clinical subtypes, risk factors and outcomes through a cross-sectional study of CP in CBR and hospital settings in Benin. We hypothesized that term-born children with severe CP would predominate in our study population, and predicted that cerebral malaria would be a common post-neonatal cause in this endemic area.

**Method**

***Study design***

This cross-sectional study included children with CP from five CBR centres and two rehabilitation departments of teaching hospitals in the south (Cotonou) and the north (Parakou) of the Republic of Benin, in West Africa. Cotonou is the economic capital of Benin, while Parakou is more rural, albeit the most economically developed area in the North of Benin. We screened patients’ registers in each setting for children between two and 17 years old diagnosed with CP and assessed phone contacts for discharged children. After identifying the patients, their families were then invited to take part in the study. Based on the CP definition of Rosenbaum et al. (2007),1 children were included if they experienced a.) motor disorders (muscle weakness or spasticity or movement disorders) b.) as a consequence of injury/maldevelopment of the developing brain; c.) with associated difficulties in daily life activities (gross or fine motor activities); d.) without sign of progressive loss of acquired abilities (checked during interview) and e.) with an onset of the disorder observed before two years of age.

The ethic committee of the rehabilitation department of the National University Hospital (Cotonou, Republic of Benin) approved the study (date of approval: 13th/06/2017). Caregivers of all participants provided their informed consent.

***Data collection***

*Risk factors*

We interviewed the children’s mothers with a structured questionnaire and reviewed medical records about socio-demographic data, and history of the pregnancy, birth, and post neonatal adverse events (see Table 1). History of pregnancy included maternal alcohol consumption, smoking, fever/infection, malaria, or abnormal bleeding during pregnancy. History of birth involved induced labour, complications during delivery, prematurity, foetal presentation, and other notable events. We could not obtain access to the children’s APGAR (Atmung, Puls, Grundtonus, Aussehen, and Reflexe, i.e. Breathing, pulse, tonus, appearance, and reflexes) scores at birth, which were not reported in medical records. As an alternate to APGAR scores, we asked the mothers for their recollection of whether the children cried at birth. Post-neonatal adverse events potentially leading to CP were reviewed in medical records.

*Clinical subtype*

We used the classification tree of the Surveillance of Cerebral Palsy in Europe (http://www.scpenetwork.eu/de/home/) white paper to group the children according to their predominant movement disorders. These were bilateral spastic CP (BS-CP), unilateral spastic CP (US-CP), dyskinetic and ataxic.16 We further classified children with BS-CP into those with spastic diplegia or quadriplegia.

*Outcomes (motor)*

The severity of gross and fine motor function impairments was classified with the Gross Motor Function Classification System (GMFCS)17 and the Manual Ability Classification System (MACS)18 respectively. Additionally, we recorded the school attendance rate of the children with CP.

*Associated comorbidities*

We searched for history of seizure by asking mothers during the structured interview whether their child often experienced fits or lost consciousness19 and by reviewing medical records for any diagnoses of epilepsy/seizure. Positive history of seizure was noted if endorsed by the mother or if mentioned in the medical records. Communication difficulties of non-verbal children and those unable to construct phrases of at least two-words were recorded when endorsed by the child’s mother, or when observed during communication between mother and child. We checked for severe visual impairment presenting with an inability to track visually a colourful and attractive toy or respond with vision-provoked behaviours such as facial expression, blinking eyes, and smiling.20 Finally, we investigated signs of cognitive impairments by asking the child’s mother: i.) if the child learns as well as his peers; ii.) if he/she needs greater help compared to his peers in learning simple tasks such as the rules of games universally played by age-peers and iii.) if he/she can understand and respond to simple orders from peers. An endorsement of two or three of these questions was considered a positive sign of cognitive impairments.

***Data analysis***

Statistical analyses of the children`s demographic and clinical characteristics were performed with SPSS IBM 25.. We used the Chi-square test to analyse for associations between categorical variables. We calculated the likelihood ratio (LR) where applicable (> 20% of expected frequencies are below 5) and the Fisher exact test for binary variables. P-value ≤ 0.05 was the threshold for statistical significance.

**Results**

*Participants*

We screened 198 children (69 in Parakou and 129 in Cotonou). Thirty-seven could not be contacted due to non-functional phone numbers. Among the 161 remaining eligible participants, 34 had moved from the region and could not be interviewed, the parents of two declined to participate, and ten children were no longer alive. One child was excluded due to an acquired brain injury from sickle cell disease at three years of age. The final sample included 114 children, of whom 70% were recruited from CBRs, with diagnosis of CP by paediatricians, neurologists and Physiatrists (Specialists in Physical medicine and rehabilitation). Table 1 presents the children’s demographic characteristics; they ranged in age from two to 17 years, with a median age of seven years. Sixty-six per cent were male, 9.6% were twins and 41.2% were firstborn.

*Risk factors*

All mothers but two had received antenatal care. Vaccination during pregnancy against tetanus was recorded in all but nine cases. Twenty-two percent mothers reported at least one adverse antenatal event, i.e. malaria, vaginal infections or abnormal bleeding. No mother smoked or used alcohol during pregnancy. Every birth was delivered at hospital, with the exception of one delivery at home unassisted by a health professional. Seven percent children were born preterm (less than 37 weeks of gestational age). More than half of the children’s mothers reported intrapartum adverse events, i.e. induced labour or complications during delivery). Fifty percent of children had not cried at birth with approximately 15 minutes of delay (median time). Seventeen percent of children suffered from post-neonatal events, mainly cerebral malaria and seizure. Demographic data for risk factors are presented in Table 1.

*Clinical subtype*

BS-CP was the most common subtype (77 children; 67.5%) including 54 (47.4% of the total sample) with quadriplegia and 23 (20.2%) subjects with diplegia. Twenty-two (19.3%) were classified as US-CP. Five (4.4%) children had dyskinesia, two (1.8%) had ataxia, and 8 (7%) were non-classified.

*Outcome*

*Motor outcome.* Children in our sample were severely impaired. Fifty-four percent of children were classified as GMFCS-IV-V and forty-five percent as MACS-IV-V (Figure 1-A). The proportion of children with severe level to MACS increased with higher GMFCS levels (LR(df) = 79.93(16), p<0.001) (figure 1-B). Consistently, BS-CP was more common in children with severe gross motor impairment, while US-CP was more common in less impaired children (LR(df) = 57.92(16) p<0.001) (Figure 1-C). We found no association between children’s age and GMFCS levels (LR(df) = 17.63(12), p = 0.13) (Figure 1-D). However, when grouping children as “independent walkers” (GMFCS I & II) and “non-walkers” (GMFCS III, IV & V), the chi-square test was statistically significant (χ2(df) = 12.27 (3), p = 0.01). The proportion of severely affected children decreased with increasing age, as shown in Figure 2. There was no association between GMFCS levels and risk factors such as “having an adverse event during pregnancy” (p=0.98), “induction of labour” (p=0.19), “crying at birth” (p=0.40), “crying delay” (p=0.74) and “admission to NICU” (p=0.19), and a borderline significant association with “complications during delivery” (p=0.05). A higher proportion of children classified as GMFCS-I were in the category of not having experienced any complications during delivery (Table 2). Regarding walking aids, 9/20 children classified as GMFCS-III used a frame or walker; four used crutches and seven used canes. Fourteen/17 children classified as GMFCS-IV and only 2/45 children as GMFCS-V were transported by their parents in a manual wheelchair either at home or at the CBR centres. Severely affected children were mostly carried on their mother`s back for long distance travel, or were placed in modified chairs at home. The proportion of children according to GMFCS level and clinical subtypes did not differ when considering only those children recruited from the CBR centres (Table 3).

*Schooling\_* Twenty-seven/103 children with CP ageing at least 3years old (preschool age), were schooled, of whom two attended school for children with special needs (one US-CP, GMFCS-II, MACS-I and the other dyskinetic, GMFCS-III, MACS-IV). The main factors associated with attendance at regular school were the severity of impairment of ambulation (GMFCS) and manual ability (MACS), as well as communication disorders and age (Table 4).

*Comorbidities*

All comorbidities but severe visual impairments are reported in Table 5. Solely three cases of severe visual impairments were identified. They were classified BS-CP (two GMFCS-V and one GMFCS-III). Signs of seizure were recorded in 19 (16.52%) children. Sixty (52.17%) children had signs of communication disorders and 89 (77.4%) showed signs of cognitive impairments. Each comorbidity except cognitive impairments was significantly associated with the clinical subtype, the GMFCS level and children’s age. The more severe the CP and the younger the child, the higher the likelihood of having a comorbidity.

**Discussion**

This cross-sectional study aimed to describe the clinical profile of children with CP in the Republic of Benin, a representative LIC in West Africa. The most frequently reported adverse events related to CP were known intrapartum risk factors. Cerebral malaria and convulsions were the main post-neonatal causes of CP. Most children were severely afflicted with CP, with BS-CP and GMFCS-IV-V. Accompanying comorbidities were mainly present in younger and severely affected children.

Risk factors leading to CP differ considerably between HICs and LMICs. Birth asphyxia is the most reported risk factor in LMICs such as Nigeria3, 21. In contrast, birth asphyxia makes a minor contribution to the incidence of in CP in HICs, where prematurity is the major risk factor (accounting for about 40% of children with CP).5 Only seven percent of the children with CP in the present study were born preterm. A low rate of preterm survival in LMICs is well reported in the literature because of the limited availability of high quality neonatal intensive care.7, 21 Determining the leading cause(s) of CP in Benin is beyond the scope of the present cross-sectional study. The likely precipitators such as birth asphyxia, birth defects, genetic factors, TORCH complex foetal infections, and multifactorial causes, may lead to an intrapartum adverse events such as induced labour, complications during delivery, or baby not crying at birth, as found in this study.22, 23 Future studies should help understanding the causes underpinning the high proportion of intrapartum risk factors occurring in Benin. We observed that complicated delivery with prolonged labour and instrumented delivery resulted less frequently in mild disability. We suppose if likely that cerebral grey matter injuries often present in term-born infants with perinatal hypoxia–ischaemia contribute importantly to the severe cases of CP.23, 24

Term-born children with CP are generally more severely affected than are preterm children, who present mainly white matter injury often leading to a milder disability.24, 25 The incidence of severe cases of CP was reported as higher in hospital-based studies in LMIC (Nigeria,10, 11 Botswana,21 Uganda26) compared to HICs, where at least two-thirds of children with CP are typically ambulatory (GMFCS I – III) and there is a trend towards fewer severe cases.5, 27, 28 Accordingly, the proportion of severe cases was higher in our LIC study. However the proportion of ambulatory children (GMFCS I, II and III) was 45.6%, which exceeds the proportions found in Nigeria (29.3%) and Botswana (40.8%).11, 21 We had expected that our recruitment of children from CBR settings would yield more cases of milder CP. However, the unexpectedly higher proportion of severe cases in CBR settings might be attributable to a recruitment bias. Parents with mildly afflicted children (GMFCS I, II) might not be motivated to bring their children for time-consuming rehabilitation care, given the constraints arising from their working life. Similarly, a recent population based-study in a rural area of Uganda in East of Sub-Saharan Africa found predominance of children with milder disability, in contrast to their earlier Ugandan hospital-based study in which severe CP was predominant.7, 26 However, the lower rate of survival of severely affected children might have given rise to higher proportion of milder cases reported in their population-based study. Indeed, the number of children with severe CP decreased dramatically with age in our study, as was likewise seen in the aforementioned population-based study. It is noteworthy that 10 of 161 eligible participants in our study were no longer alive during the recruitment phase. The apparently low rate of survival of severely affected children in Benin and other African LICs raises the question of quality of care provided to these children. Indeed, the management of CP does not follow any specific guidelines in the Republic of Benin, as it is the case in other LMICs in Sub-Saharan Africa.15 Where there are limited resources for CP prevention, the quality of care is lower for affected children. There is need in LMICs such as Benin to promote evidence-based rehabilitation care including intensive neuro-rehabilitation approaches such as Hand-Arm Bimanual Intensive Therapy including Lower Extremity (HABIT-ILE), Constraint-induced movement therapy (CIMT) goal-directed training, etc. adapted to LMICs.29, 30 That would help to improve the quality of care provided to children with CP.

The proportion of post-neonatal cases of CP was higher in our study compared to findings in HICs, where estimates are less than 10%.23, 27 This same trend was observed in other clinically-based studies including one in Nigeria and the population-based study in Uganda.7, 10, 21 Post-neonatal CP in HICs is mainly due to head injury, especially cerebrovascular accident, and secondarily to infections.31, 32 Infections are the major cause of post-neonatal cases of CP in LMICs. In our study, cerebral malaria and seizures were the main post neonatal causes of CP. Seizure can be a consequence of CP – whatever its cause - and is almost systematically observed in cerebral malaria, as previously reported in Uganda.7 Intracranial infections and bilirubin encephalopathy secondary to jaundice were the most frequently reported causes of post-neonatal CP in Nigeria.10, 11 Malaria is prevalent in children in Benin with a reported incidence of 84/1000 children per month, and most parents try to treat their children at home, only seeking hospitalization in difficult cases.33, 34 Consequently, cerebral malaria is common in children in Benin, and brings a mortality rate of 47% according to a recent study.33, 35 Moreover, malaria was the most reported health issue during pregnancy in our cohort. Malaria is also highly prevalent in pregnant women in Benin, and is associated with fetal growth restrictions.36, 37 Prevention and management of malaria both in pregnant women and in children must be emphasized with the implication of health-decisions makers in people’s education, provision of long lasting insecticidal nets and free access to hospital for pregnant women early during the first trimester, in order to reduce the incidence of CP in endemic areas such as Benin.37, 38

Schooling of children with disability present a serious challenge in LMICs. In Benin, there are practically no public schools for children with special needs and disability. As a result, most children with significant disability simply do not attend school, as was the case of 74% of our cohort. Considering milder cases ( independent walkers, GMFCS I-II) one third did not attend school, while the national net rate of children’s school attendance is estimated at 87%.39 Factors associated with school non-attendance were impaired ability to ambulate and manipulate objects and communication disorders. In a recent study carried out in Benin, Kpadonou et al. reported high rate of school drop-out by handicapped children because of low academic success.35 Other than particular aspects of their handicaps, factors linked to low success rate included difficulties of school accessibility, social marginalization, and lack of help.35 It is noteworthy that the social environment plays a significant role in restraining children with disability from participating in social activities. In Benin, there are practically no accommodations in public settings to facilitate accessibility for non-ambulatory children in need of assistive devices such as manual or powered wheelchairs. In contrast, such devices are freely available in HICs, which facilitates participation even of children with severe CP in schooling, playing, and other social activities.40 These findings emphasize the crucial role of public health policies in the fight against disability in LMICs.

Limitations:

We cannot generalize present findings to the whole population of CP in Benin since this is not a population-based study. However, having drawn the sample from CBR settings make it likely representative of the population of children with CP in Benin. Indeed, CBR are organized within the communities by community members and are freely accessible for any parent of children with CP or any other developmental disability. As such, it offers the opportunity to meet broad cases (even milder) whose parents could not afford institutional-based cares that are generally far from their locations. Data were mainly collected through interviews, which might result in a recall bias in the results. Moreover, by limiting our study group to children diagnosed with CP in CBR and hospital centres, we miss important factors such as neonatal and infant general death rates. Asking mothers to recollect whether their children cried at birth is not an ideal proxy measure of breathing and is certainly not equivalent to the entire APGAR score, which represents a limitation in this study. Furthermore, we missed the assessment of other comorbidities such as hearing impairment, undernutrition, musculoskeletal disorders, such assessments that were possible were confined to simple checks for severe visual impairments or blindness, and signs of seizures, which were scantly explored through interviews without clinical confirmation. This may have induced bias in the reported proportion of children experiencing seizures. Moreover, we used only simple questions to explore cognitive impairments. A standard validated tool such as the Wechsler intelligence scales41 would have been better, but there is currently no adaptation of this tool to the socio-cultural context of Benin. Furthermore, the low access to assistive equipment might induce a bias in this study, since children with an actual ability of GMFCS III or IV might be mis-classified as GMFCS IV or V due to the lack of equipment such as manual or electric wheelchair. Population-based and longitudinal studies are needed to obtain a deeper understanding of CP in West Africa.

**Conclusion**

CP is a cause of severe cognitive and motor disability in Beninese children and is a life threatening health issue in the younger age group. The incidence of CP is largely attributable to preventable risk factors such as intrapartum adverse events and cerebral malaria, emphasizing the necessity of improved public health policies in a representative LIC of West Africa for CP prevention and better quality of post-natal care. Low school attendance of children with CP in Benin reflect the lack of dedicated schools for children with special needs, the inadequate social environment, and the poor availability of supply of assistive devices.

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**References**

1. Rosenbaum P, Paneth N, Leviton A, et al. A report: the definition and classification of cerebral palsy April 2006. *Developmental medicine and child neurology Supplement* 2007; 109: 8-14. 2007/03/21.

2. Goldsmith S, McIntyre S, Smithers-Sheedy H, et al. An international survey of cerebral palsy registers and surveillance systems. *Developmental medicine and child neurology* 2016; 58 Suppl 2: 11-17. 2016/01/20. DOI: 10.1111/dmcn.12999.

3. Donald KA, Samia P, Kakooza-Mwesige A, et al. Pediatric cerebral palsy in Africa: a systematic review. *Seminars in pediatric neurology* 2014; 21: 30-35. 2014/03/25. DOI: 10.1016/j.spen.2014.01.001.

4. Oskoui M, Coutinho F, Dykeman J, et al. An update on the prevalence of cerebral palsy: a systematic review and meta-analysis. *Developmental medicine and child neurology* 2013; 55: 509-519. 2013/01/26. DOI: 10.1111/dmcn.12080.

5. Reid SM, Meehan E, McIntyre S, et al. Temporal trends in cerebral palsy by impairment severity and birth gestation. *Developmental medicine and child neurology* 2016; 58 Suppl 2: 25-35. 2016/01/15. DOI: 10.1111/dmcn.13001.

6. Sellier E, Platt MJ, Andersen GL, et al. Decreasing prevalence in cerebral palsy: a multi-site European population-based study, 1980 to 2003. *Developmental medicine and child neurology* 2016; 58: 85-92. 2015/09/04. DOI: 10.1111/dmcn.12865.

7. Kakooza-Mwesige A, Andrews C, Peterson S, et al. Prevalence of cerebral palsy in Uganda: a population-based study. *The Lancet Global health* 2017; 5: e1275-e1282. 2017/11/06. DOI: 10.1016/s2214-109x(17)30374-1.

8. El-Tallawy HN, Farghaly WM, Shehata GA, et al. Cerebral palsy in Al-Quseir City, Egypt: prevalence, subtypes, and risk factors. *Neuropsychiatric disease and treatment* 2014; 10: 1267-1272. 2014/07/22. DOI: 10.2147/ndt.S59599.

9. El-Tallawy HN, Farghaly WM, Shehata GA, et al. Epidemiology of cerebral palsy in El-Kharga District-New Valley (Egypt). *Brain & development* 2011; 33: 406-411. 2010/08/28. DOI: 10.1016/j.braindev.2010.07.011.

10. Lagunju IA and Adedokun BO. A comparison of quadriplegic and hemiplegic cerebral palsy. *Journal of Pediatric Neurology* 2008; 6: 25-30.

11. Ogunlesi T, Ogundeyi M, Ogunfowora O, et al. Socio-clinical issues in cerebral palsy in Sagamu, Nigeria. *South African Journal of Child Health* 2008; 2.

12. Gladstone M. A review of the incidence and prevalence, types and aetiology of childhood cerebral palsy in resource-poor settings. *Annals of tropical paediatrics* 2010; 30: 181-196. 2010/09/11. DOI: 10.1179/146532810x12786388978481.

13. Organization WH. Community-based rehabilitation: CBR guidelines. 2011.

14. Patel P, Baier J, Baranov E, et al. Health beliefs regarding pediatric cerebral palsy among caregivers in Botswana: A qualitative study. *Child: care, health and development* 2017; 43: 861-868.

15. Donald KA, Kakooza AM, Wammanda RD, et al. Pediatric Cerebral Palsy in Africa: Where Are We? *Journal of child neurology* 2015; 30: 963-971. 2014/10/10. DOI: 10.1177/0883073814549245.

16. Cans C, Dolk H, Platt M, et al. Recommendations from the SCPE collaborative group for defining and classifying cerebral palsy. *Developmental Medicine & Child Neurology* 2007; 49: 35-38.

17. Palisano RJ, Cameron D, Rosenbaum PL, et al. Stability of the gross motor function classification system. *Developmental medicine and child neurology* 2006; 48: 424-428. 2006/05/17. DOI: 10.1017/s0012162206000934.

18. Eliasson A-C, Krumlinde-Sundholm L, Rösblad B, et al. The Manual Ability Classification System (MACS) for children with cerebral palsy: scale development and evidence of validity and reliability. *Developmental medicine and child neurology* 2006; 48: 549-554.

19. Durkin MS, Hasan ZM and Hasan KZ. The ten questions screen for childhood disabilities: its uses and limitations in Pakistan. *Journal of epidemiology and community health* 1995; 49: 431-436. 1995/08/01.

20. Porro G, Dekker EM, Van Nieuwenhuizen O, et al. Visual behaviours of neurologically impaired children with cerebral visual impairment: an ethological study. *The British journal of ophthalmology* 1998; 82: 1231-1235. 1999/01/30.

21. Bearden DR, Monokwane B, Khurana E, et al. Pediatric Cerebral Palsy in Botswana: Etiology, Outcomes, and Comorbidities. *Pediatric neurology* 2016; 59: 23-29. 2016/04/27. DOI: 10.1016/j.pediatrneurol.2016.03.002.

22. MacLennan AH, Thompson SC and Gecz J. Cerebral palsy: causes, pathways, and the role of genetic variants. *American journal of obstetrics and gynecology* 2015; 213: 779-788. 2015/05/25. DOI: 10.1016/j.ajog.2015.05.034.

23. Graham HK, Rosenbaum P, Paneth N, et al. Cerebral palsy. *Nature reviews Disease primers* 2016; 2: 15082. 2016/05/18. DOI: 10.1038/nrdp.2015.82.

24. Himmelmann K and Uvebrant P. Function and neuroimaging in cerebral palsy: a population-based study. *Developmental medicine and child neurology* 2011; 53: 516-521. 2011/05/18. DOI: 10.1111/j.1469-8749.2011.03932.x.

25. Reid SM, Dagia CD, Ditchfield MR, et al. An Australian population study of factors associated with MRI patterns in cerebral palsy. *Developmental medicine and child neurology* 2014; 56: 178-184. 2014/01/17. DOI: 10.1111/dmcn.12331.

26. Kakooza-Mwesige A, Forssberg H, Eliasson AC, et al. Cerebral palsy in children in Kampala, Uganda: clinical subtypes, motor function and co-morbidities. *BMC research notes* 2015; 8: 166. 2015/04/24. DOI: 10.1186/s13104-015-1125-9.

27. Forni R, Stojicevic V, van Son C, et al. Epidemiology of Cerebral Palsy in Northeastern Switzerland. *Pediatric physical therapy : the official publication of the Section on Pediatrics of the American Physical Therapy Association* 2018; 30: 155-160. 2018/03/27. DOI: 10.1097/pep.0000000000000491.

28. Sigurdardottir S, Thorkelsson T, Halldorsdottir M, et al. Trends in prevalence and characteristics of cerebral palsy among Icelandic children born 1990 to 2003. *Developmental medicine and child neurology* 2009; 51: 356-363. 2009/04/24.

29. Novak I, McIntyre S, Morgan C, et al. A systematic review of interventions for children with cerebral palsy: state of the evidence. *Developmental medicine and child neurology* 2013; 55: 885-910. 2013/08/22. DOI: 10.1111/dmcn.12246.

30. Bleyenheuft Y, Ebner-Karestinos D, Surana B, et al. Intensive upper- and lower-extremity training for children with bilateral cerebral palsy: a quasi-randomized trial. *Developmental medicine and child neurology* 2017; 59: 625-633. 2017/01/31. DOI: 10.1111/dmcn.13379.

31. Blair E, Watson L, O'Kearney E, et al. Comparing risks of cerebral palsy in births between Australian Indigenous and non-Indigenous mothers. *Developmental medicine and child neurology* 2016; 58 Suppl 2: 36-42. 2016/01/20. DOI: 10.1111/dmcn.13005.

32. Smithers-Sheedy H, McIntyre S, Gibson C, et al. A special supplement: findings from the Australian Cerebral Palsy Register, birth years 1993 to 2006. *Developmental medicine and child neurology* 2016; 58 Suppl 2: 5-10. 2016/01/15. DOI: 10.1111/dmcn.13026.

33. Moussiliou A, Alao MJ, Denoeud-Ndam L, et al. High plasma levels of soluble endothelial protein C receptor are associated with increased mortality among children with cerebral malaria in Benin. *The Journal of infectious diseases* 2014; 211: 1484-1488.

34. Nahum A, Erhart A, Mayé A, et al. Malaria incidence and prevalence among children living in a peri-urban area on the coast of Benin, West Africa: a longitudinal study. *The American journal of tropical medicine and hygiene* 2010; 83: 465-473.

35. Kpadonou G, Alagnidé E, Gbenou S, et al. Problèmes de scolarisation des enfants handicapés au Bénin. *Motricité Cérébrale: Réadaptation, Neurologie du Développement* 2013; 34: 137-144.

36. Briand V, Saal J, Ghafari C, et al. Fetal growth restriction is associated with malaria in pregnancy: a prospective longitudinal study in Benin. *The Journal of infectious diseases* 2016; 214: 417-425.

37. Accrombessi M, Fievet N, Yovo E, et al. Prevalence and Associated Risk Factors of Malaria in the First Trimester of Pregnancy: A Preconceptional Cohort Study in Benin. *J Infect Dis* 2018; 217: 1309-1317. 2018/01/13. DOI: 10.1093/infdis/jiy009.

38. Djènontin A, Egbinola S, Fievet N, et al. Impact of impregnated net’s use and efficacy on malaria during the pregnancy’s first trimester, Benin. *European Journal of Public Health* 2018; 28. DOI: 10.1093/eurpub/cky214.092.

39. INSAE. Indicateurs scolaires au niveau de l’enseignement primaire au Bénin de 2003 à 2012. Available from: https://www.insae-bj.org/ [cited 2019, March 28].

40. Palisano RJ, Tieman BL, Walter SD, et al. Effect of environmental setting on mobility methods of children with cerebral palsy. *Developmental medicine and child neurology* 2003; 45: 113-120. 2003/02/13.

41. Wechsler D. *Wechsler Intelligence Scale for Children*. San Antonio, TX, US: Psychological Corporation, 1949.

**Figure legends**

**Figure 1**: Distribution of children in Benin with cerebral palsy (CP) according to their MACS & GMFCS Levels (A). Distribution of MACS level (B) and CP subtype (C) by GMFCS level ( percentage of total number of each GMFCS level). Distribution of GMFCS levels by children’s age (D). GMFCS = Gross Motor Function Classification System. MACS = Manual Ability Classification System.

**Figure 2**: Distribution of children in Benin with cerebral palsy (CP) according to their GMFCS levels grouped as “independent walkers” (Level I & II) and “Non-Walkers” (Level III to V) and their ages.

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| Table1: Sociodemographic characteristics and risk factors of 114 children with CP in Benin. | |
| Characteristics | Values |
| Age (years), median [IQR] | 7 [4 ; 11.1] |
| Gender |  |
| Female, n (%) | 39 (34.2) |
| Male, n (%) | 75 (65.8) |
| \*Birth weight (kg), median [IQR] (n=96) | 3 [2.5 ; 3.5] |
| Siblings, median [IQR] | 3 [2 ; 4] |
| Firstborn, n (%) | 47 (41.2) |
| Attending school, n (%) | 27 (23.7) |
| Ordinary / specialized school (n) | 25/2 |
| Residence (Rural/Urban) (n) | 25/89 |
| Fathers' level of education, n (%) |  |
| Not educated | 7 (6.1) |
| Primary school | 38 (33.3) |
| Secondary (college) | 37 (32.5) |
| University | 23 (20.2) |
| Mothers' level of education, n (%) |  |
| Not educated | 30 (26.3) |
| Primary school | 44 (38.6) |
| Secondary (college) | 28 (24.6) |
| University | 12 (10.5) |
| Maternal age at delivery (years), median [IQR] | 28[23 ; 33] |
| Risk factors in pregnancy |  |
| Smoking (%) | 0 |
| Alcohol consumption (%) | 0 |
| Received antenatal care, n (%) | 112 (98.2) |
| Malaria, n (%) | 17 (14.9) |
| Infection, n (%) | 10 (8.8) |
| Abnormal bleeding, n (%) | 4 (3.5) |
| History of birth delivery |  |
| Birth delivery in hospital, n (%) | 113 (99.1%) |
| Caesarean section, n (%) | 16 (14) |
| Preterm birth (<37 wks), n (%) | 8 (7) |
| Induction of labour, n (%) | 60 (52.6) |
| Complications during delivery, n (%) | 60 (52.6) |
| Breech presentation, n (%) | 1 (0.9) |
| Not crying at birth, n (%) | 61 (53.5) |
| \*Crying delay (min), median [IQR] (n=54) | 15 [5 ; 30] |
| Admitted into NICU, n (%) | 53 (46.5) |
| \*Days into NICU, median [IQR] | 14 [7 ; 21] |
| \*Post-neonatal events, n (%) | 19 (16.7) |
| Seizure/Convulsions | 5 (4.4) |
| Cerebral malaria | 7 (6.1) |
| Meningitis | 4 (3.5) |
| Jaundice | 2 (1.8) |
| Head traumatism | 1 (0.9) |
| \* = Data extracted from medical records. IQR= Interquartile range [Percentile25; Percentile75]; Min = minutes, wks = weeks. NICU = Neonatal Intensive Care Unity. | |

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| Table 2: Risk factors associated with motor outcome (GMFCS levels) in Beninese children with CP | | | | | | | |
| Risk factors | | GMFCS (% in variables)) | | | | | Statistic test |
| I | II | III | IV | V |
| Pregnancy adverse event | Yes | 4  (16%) | 3  (12%) | 5  (20%) | 3  (12%) | 10 (40%) | LR(df) = 0.41 (4), p = 0.98 |
| No | 16  (18%) | 9 (10.1%) | 15 (16.9%) | 14 (15.7%) | 35 (39.3%) |
| Induction of labor | Yes | 7  (11.9%) | 9 (15.3%) | 12 (20.3%) | 10 (16.9%) | 21 (35.6%) | X² (df) = 6.2 (4), p = 0.19 |
| No | 13 (23.6%) | 3  (5.5%) | 8 (14.5%) | 7 (12.7%) | 24 (43.6%) |
| Complications in delivery | Yes | 6  (10%) | 10 (16.7%) | 12  (20%) | 8 (13.3%) | 24  (40%) | **X² (df) = 9.3 (4), p = 0.05** |
| No | 14 (25.9%) | 2  (3.7%) | 8 (14.8%) | 9 (16.7%) | 21 (38.9%) |
| Crying at birth | Yes | 13 (25.5%) | 5  (9.8%) | 7 (13.7%) | 7 (13.7%) | 19 (37.3%) | X² (df) = 4.04 (4), p = 0.40 |
| No | 7  (11.3%) | 7 (11.3%) | 12 (19.4%) | 10 (16.1%) | 26 (41.9%) |
| Crying delay | < 15 min | 16 (21.9%) | 7  (9.6%) | 13 (17.8%) | 10 (13.7%) | 27  (37%) | X² (df) = 1.97 (4), p = 0.74 |
| ≥15 min | 4  (12.1%) | 3  (9.1%) | 5 (15.2%) | 6 (18.2%) | 15 (45.5%) |
| Admission to NICU | Yes | 6  (11.1%) | 7  (13%) | 7  (13%) | 8 (14.8%) | 26 (48.1%) | X² (df) = 6.18 (4), p = 0.19 |
| No | 14 (23.2%) | 5  (8.3%) | 13 (21.7%) | 9  (15%) | 19 (31.7%) |
| Note: GMFCS = Gross motor function classification system; LR = Likelihood ratio; df = degree of freedom; “bold” = significant statistic test. | | | | | | | |

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| Table 3: Distribution of children from the whole sample and recruited from CBR according to GMFCS and the CP clinical subtype | | | | | | | | | | | |
|  | GMFCS | | | | |  | Clinical subtype | | | | |
|  | I | II | III | IV | V |  | US-CP | BS-CP | Ataxia | Dyski | N-C |
| Whole sample  N (%) | 20  (17.5) | 12  (10.5) | 20  (17.5) | 17  (14.9) | 45  (39.5) |  | 22  (19.3) | 77  (67.5) | 2  (1.8) | 5  (4.4) | 8  (7.0) |
| CBR, n (%) (N = 78) | 15  (19.2) | 11  (14.1) | 10  (12.8) | 11  (14.1) | 31  (39.7) |  | 14  (17.9) | 55  (70.5) | 1  (1.3) | 4  (5.1) | 4  (5.1) |
| Note : GMFCS = Gross Motor Function Classification System; US-CP = Unilateral spastic cerebral palsy; BS-CP = Bilateral spastic cerebral palsy; Dyski = dyskinesia, N-C = Non-classifiable. N =78 is the size of children from CBR. | | | | | | | | | | | |

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| Table 4: Distribution of schooled children with CP according to their demographic and clinical characteristics. | | |
| Variables | Schooled (% in variables) | statistical test |
| Age (years) |  |  |
| [3; 6[ | 4/33 (12.1%) |  |
| [6; 10[ | 8/36 (22.2%) | LR(df) = 9.52(3) , p=0.02 |
| [10; 14[ | 9/19 (47.4%) |  |
| [14; 18[ | 6/15 (40%) |  |
| Sex |  |  |
| Female | 8/33 (24.2%) | \*p=0.82 |
| Male | 19/70 (27.1%) |  |
| MACS regrouped |  |  |
| MACS-I-II | 20/46 (43.5%) |  |
| MACS-III | 2/11 (18.2%) | χ2(df) = 13.06(2), p=0.001 |
| MACS-IV-V | 5/46 (10.9%) |  |
| GMFCS\_grouped |  |  |
| GMFCS-I-II | 20/30 (66.7%) |  |
| GMFCS-III | 4/17 (23.5%) | χ2(df) = 38.04(2), p<0.001 |
| GMFCS-IV-V | 3/56 (5.4%) |  |
| cognitive impairments |  |  |
| Yes | 17/80 (21.3%) | \*p = 0.06 |
| No | 10/23 (43.5%) |  |
| communication disorders |  |  |
| Yes | 2/55 (3.6%) | \*p<0.001 |
| No | 25/48 (52.1.5%) |  |
| Residence |  |  |
| Urban | 22/82 (26.8%) | \*p=0.99 |
| Rural | 5/25 (23.8%) |  |
| Father's education level |  |  |
| Not educated | 3/7 (42.9%) |  |
| Primary school | 7/34 (20.6%) | χ2(df) = 1.63(3) , p=0.65 |
| Secondary school | 9/32 (28.1%) |  |
| University | 6/22(27.3%) |  |
| Mother's level of education |  |  |
| Not educated | 7/28 (25%) |  |
| Primary school | 11/40 (27.5%) | χ2(df) = 0.34(3) , p=0.95 |
| Secondary school | 7/24 (29.2%) |  |
| University | 2/10 (20%) |  |
| Note: GMFCS = Gross motor function classification system; MACS = Manual ability classification system; \* = Fischer exact test. | | |

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| Table 5: Comorbidities associated with cerebral palsy according to CP motor subtype, GMFCS level and age. | | | |
|  | Seizure  (n=18; 16.5%) | Communication disorders  (n= 59; 52.17%) | Cognitive impairments  (n=88; 77.4%) |
| Unilateral spastic (n=22) | 1 (4.5%) | 4 (18.2%) | 15 (68.2%) |
| Bilateral spastic (n=77) | 13 (16.9%) | 46 (59.7%) | 61 (79.2%) |
| Dyskinesia/ataxia (n=7) | 4 (57.1%) | 6 (85.7%) | 5 (71.4%) |
| Non-classified (n=8) | 0 (0%) | 3 (37.5%) | 7 (87.5%) |
| *Statistical test* | *LR(df)=11.89(3), p=0.018* | *LR(df)=19.87(3), p=0.001* | *LR(df)=3.71(3), p=0.447* |
|  | | | |
| GMFCS-I (n=20) | 1 (5%) | 3 (15%) | 13 (65%) |
| GMFCS-II (n=12) | 0 (0%) | 2 (16.7%) | 9 (75%) |
| GMFCS-III (n=20) | 3 (15%) | 8 (40%) | 15 (75%) |
| GMFCS-IV (n=17) | 1 (5.9%) | 9 (52.9%) | 12 (70.60%) |
| GMFCS-V (n=45) | 13 (28.9%) | 37 (82.2%) | 39 (86.7%) |
| *Statistical test* | *LR(df)=12.87(4), p=0.012* | *χ2(df)= 37.63(4), p<0.001* | *LR(df)= 5.67(4), p=0.225* |
| Age (year) | | | |
| [2; 6] (n=44) | 9 (20.5%) | 25 (56.8%) | 34 (77.3%) |
| [6; 10] (n=36) | 8 (22.2%) | 21 (58.3%) | 29 (80.6%) |
| [10; 14] (n=19) | 0 (0%) | 10 (52.6%) | 13 (68.4%) |
| [14; 18] (n=15) | 1 (6.7%) | 3 (20%) | 12 (80%) |
| *Statistical test* | *LR(df) = 9.37(3), p=0.025* | *LR(df) = 7.52(3), p=0.057* | *LR(df) = 0.37(3), p=0.947* |
| Note: GMFCS = Gross Motor Function Classification System. LR= Likelihood ratio. | | | |