Mid-upper arm circumference at age of routine infant vaccination to identify infants at elevated risk of death: a retrospective cohort study in the Gambia

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Objective To determine the predictive value for death before 12 months of age of mid-upper arm circumference (MUAC) and weight-for-length *Z* score (WFL*z*).

Methods A retrospective cohort analysis of infants living in Keneba, in rural Gambia, was conducted. Anthropometric measures were obtained from demographic surveillance system records for infants registered between February 1974 and July 2008 who had had MUAC and WFL*z* recorded at 6–14 weeks of age and vital status recorded at least once more. Hazard ratios (HRs), population attributable fractions and areas under receiver operating characteristic (ROC) curves were estimated to assess the predictive value for death in infancy of MUAC and WFL*z*.

Findings Of 2876 infants included in the analysis, 40 died before the age of 12 months. The HR for death in this group versus in well-nourished infants was 5.8 (95% confidence interval, CI: 1.6–21) for a WFL*z* < −3. HRs for MUACs below the thresholds of 115 mm, 110 mm and 105 mm were 4.5 (95% CI: 1.4–15), 9.5 (95% CI: 2.6–35) and 23 (95% CI: 4.2–122), respectively. The attributable fractions for a MUAC < 130 mm and a WFL*z* < 0 were 51% and 13%, respectively. The areas under the ROC curve for death in infancy were 0.55 (95% CI: 0.46 to 0.64) for WFLz and 0.64 (95% CI: 0.55 to 0.73) for MUAC.

Conclusion Among infants aged 6 to 14 weeks, unadjusted MUAC showed good performance in identifying infants at increased risk of death.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

Recent estimates indicate that 8.5 million infants less than 6 months of age throughout the world are wasted by World Health Organization (WHO) growth standards, which define wasting as a weight-for-length *Z* score (WFL*z*) of < −2.[1,2] The risk of undernutrition in infancy is increased in preterm and low-birth-weight infants and in infants born to young, rural, poorly nourished mothers of lower socioeconomic or educational status.[3–5] Additionally, in poor regions, low rates of exclusive breastfeeding and mixed feeding as early as 2 months of age expose infants to contamination and to foods with low nutrient density.[6]

Anthropometric measures and suitable thresholds for intervention are normally assigned on the basis of their predictive value with respect to death, ideally calculated using data from untreated populations. However, a lack of data for infants aged under 6 months,[7] among whom mortality is higher than in any other paediatric age group, makes it difficult to interpret anthropometric measures to guide interventions in this age group.

Among children aged 6 to 60 months, simple anthropometric indices are strongly associated with the risk of death.[8–14] For children aged 0 to 60 months, WHO recommends using WFL*z* to define wasting,[15] since WFL*z* is a measure of undernutrition adjusted for height and therefore independent of stunting in its description of wasting. For any given anthropometric measure, a *Z* score indicates how many standard deviations below or above a reference median an individual value is found. According to WHO growth standards, WFL*z* below the cut-off value of −3 standard deviations (SDs) from the median defines severe wasting (also called severe acute malnutrition); WFL*z* below the cut-off value of −2 but no lower than −3 defines moderate wasting (also called moderate acute malnutrition).[16] In children aged 6 to 60 months, the mid-upper arm circumference (MUAC), with simple cut-offs, is at least as predictive of death as WFL*z*.[17–20] Within this age group, adjusting MUAC by calculating the *Z* score or adjusting for height does not improve MUAC's predictive value.[21] MUAC can be measured easily, quickly and affordably. Values below the cut-offs of 125 mm and 115 mm are used to define moderate and severe acute malnutrition, respectively. MUAC is currently not recommended for use among infants aged below 6 months because of a lack of data on its reliability, measurement in practice and predictive value for death. However, we recently reported that in rural Kenya the inter-observer reliability of MUAC among infants aged 0 to 6 months was greater than that of WFL*z*.[22]

In the last twodecades, infant vaccination coverage in rural Africa has greatly improved.[23] Attendance at well baby clinics provides an opportunity for vaccination, nutrition and health screening and intervention. Our primary aim was to use data from a long-standing demographic surveillance system (DSS) in the Gambia to determine whether MUAC, measured at the age when infants attend clinics for routine vaccination (i.e. between 6 to 14 weeks), can predict all-cause infant death. Additionally, we aimed to compare the association between MUAC and infant death with that between WFL*z* and infant death, as well as to discuss potential MUAC cut-off values for use in infants 6 to 14 weeks of age.

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Methods

Study site

Since 1974, the British Medical Research Council has maintained a field station in Keneba, the Gambia. The site comprises the villages of Keneba, Manduar and Katong Kunda and is collectively known as "Keneba". Keneba has been under a longitudinal Demographic and Health Survey system since 1949.[24,25] The population is predominantly composed of Muslim subsistence farmers with similar socioeconomic status, cultural beliefs and practices.[25] Due to their proximity to each other, the three villages experience a similar climate, with a short rainy season between June and September (wet hungry season) and a longer, dry "harvest" season between October and May.[26–31]

Age, anthropometric measurements and death

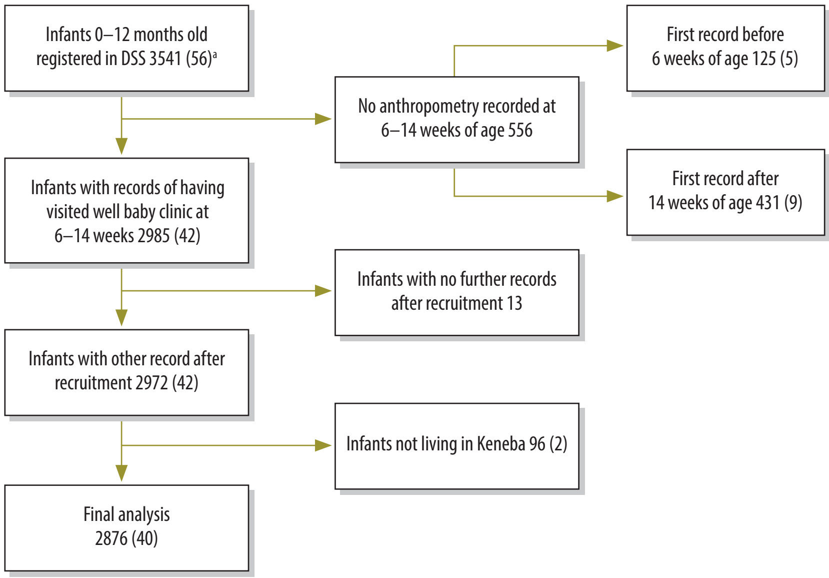
Before 1975, village births and deaths were reported weekly to the DSS team in Keneba through Arabic-literate village informants, included in the DSS team to ensure the accuracy of the information obtained from the allocated households. However, since 1975 birth dates have been obtained from postnatal care clinic and hospital records, in addition to village informants.[32–34]

The anthropometric data described in this study were collected by trained health workers (nurses and midwives) during monthly well baby clinics (established in Keneba in 1975), during postnatal care clinic visits (at 6 weeks and 3 months of age), or through the periodic DSS survey. Hospital deaths were ascertained using hospital records and home deaths using village informants. All data on deaths in hospital and at home were compared with DSS data for verification. Refresher training sessions on anthropometry were organized annually by the DSS team at the Keneba field station. No specific interventions were in place to treat malnutrition in infants aged below 6 months.

Study participants

We included data from infants aged 6 to14 weeks who were registered in the Keneba DSS between February 1974 and July 2008 if their MUAC and WFL*z* had been recorded at 6 to14 weeks of age and their vital status had been recorded at least once more (Fig. 1). Infants who were not normally living in Keneba were excluded.

Fig. 1. **Selection criteria for Gambian infants included in retrospective cohort study of the association between anthropometric measures and risk of death in infancy**



DSS, demographic surveillance system.
[a] Values in parentheses represents the number of infants who died before 12 months of age within the sample.

Study design

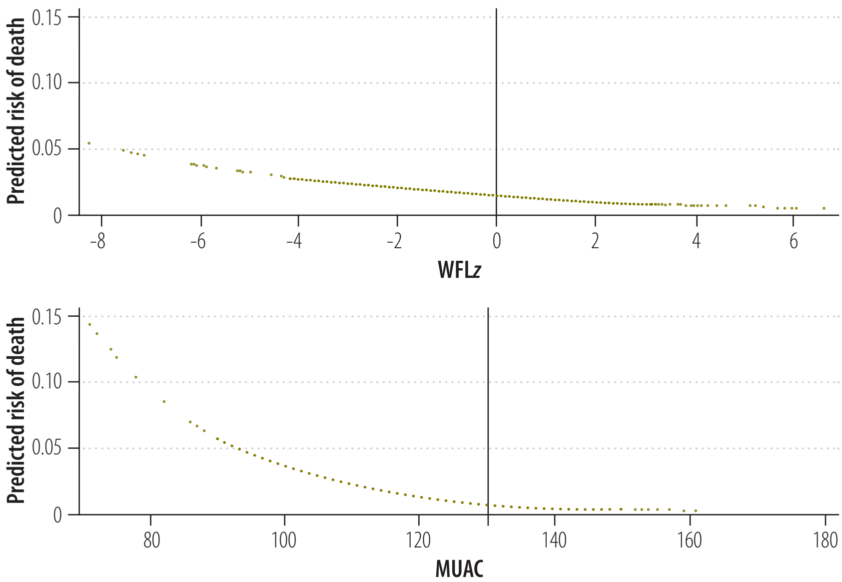
We conducted a retrospective cohort analysis of longitudinal data from infants 6 to14 weeks old who were followed until 12 months of age. The primary outcome was death within 12 months of the date of birth.

Statistical analysis

Data were analysed using STATA 12 (StataCorp. LP, College Station, United States of America). Absolute measures of MUAC and length were excluded from the analysis if they were not biologically plausible for infants aged 6 to 14 weeks (i.e. MUAC < 70 mm; length < 400 mm or > 750 mm). WFL*z* categories were then defined according to the WHO growth standards.[35] MUAC *Z*-scores could not be calculated for infants aged less than 3 months because the WHO standards apply to infants aged 3 months or older. We therefore explored the data to determine an appropriate equivalent reference cut-off for the MUAC analysis. We used generalized binomial linear regression models to predict the risk of death in infancy, which was plotted for different MUAC and WFL*z* values. The number of deaths "plateaus" at a MUAC of approximately 130 mm and a WFL*z* of 0 (Fig. 2). We therefore chose as the reference category a MUAC greater than or equal to the cut-off value of 130 mm (which also approximates the median MUAC for three-month-old infants in the WHO growth reference population), and we investigated MUAC thresholds of 115 mm, 110 mm and 105 mm. For WFL*z*, we chose WFL*z* ≥ 0 as the reference category and investigated integer thresholds of −1, −2 and −3.

We used the Kruskal–Wallis test to detect median differences in MUAC and WFL*z* and the χ^2 test for trend to detect associations between the proportion of infants who died and different anthropometric categories. We used Cox proportional hazards regression to compare hazards of mortality between anthropometric categories. Hazard ratios (HRs) for dying by 12 months of age were estimated for MUAC and WFL*z* in two ways. First, HRs were estimated by comparing individual MUAC and WFL*z* measures with the reference categories (i.e. ≥ 0 for WFL*z* and ≥ 130 mm for MUAC). Then, to examine the performance of potential cut-off values, we estimated HRs by defining exposure as MUAC or WFL*z* below each of the thresholds that we

Fig. 2. **Predicted risk of death in infancy associated with specific cut-offs for mid-upper arm circumference (MUAC) and weight-for-length *Z score* (WFLz) in Gambian infants**



Note: Vertical lines represent WFLz = 0 and MUAC = 130 mm.

Table 1. **Distribution of deaths and estimated hazard ratio (HR) for grouped MUAC and WFLz categories with follow-up to 12 months of age**

Measure	No. (%)	Died		HR for death (95% CI)
		No.	%	
MUAC (mm) (*n* = 2874)				
≥ 130[a]	635 (22)	4	0.6	1
< 130 but ≥ 115	1471 (51)	18	1.2	2.3 (0.7–6.8)
< 115 but ≥ 110	376 (13)	5	1.3	2.8 (0.7–11.9)
< 110 but ≥ 105	191 (7)	5	2.6	6.7 (1.5–30)
< 105	201 (7)	8	4.0	23 (4.2–122)
< 110	–	–	–	9.5 (2.6–35)
< 115	–	–	–	4.5 (1.4–15)
WFLz (*n* = 2867)				
≥ 0[a]	1590 (55)	17	1.1	1
< 0 but ≥ −1	790 (28)	15	1.9	1.8 (0.9–3.6)
< −1 but ≥ −2	341 (12)	5	1.5	1.4 (0.5–3.8)
< −2 but ≥ −3	86 (3)	0	0	–
< 3	60 (2)	3	5.0	5.8 (1.6–21)
< −2	–	–	–	1.9 (0.6–6.8)
< −1	–	–	–	1.5 (0.6–3.5)

CI, confidence interval; MUAC mid-upper arm circumference; WFLz, weight-for-length *Z score*.
[a] Reference group.

investigated. The HRs were adjusted for exact age in days at visit, sex, decade and season of birth and are presented with their 95% confidence intervals (CIs). According to one study, children born during June to October in the Gambia are at elevated risk of death,[36] although more recent evidence suggests that this effect is waning.[25] We also controlled for decade of birth because, since the data span four decades, we wanted to account for changes in the health system or other temporal effects. We estimated the sensitivities and specificities of MUAC and WFLz and used receiver operating characteristic (ROC) curves to assess their discriminatory ability to predict death by 12 months of age. To assess the contribution of MUAC and WFLz to infant mortality, we calculated the sample attributable risk following the method of Garenne et al.,[37] which considers nutritional status and relative hazards as continuous variables.

Ethical considerations

Ethical approval was granted by the Gambian government/Medical Research Council Laboratories Joint Ethics Committee (L2008.82vs01, 11 November 2008) and the London School of Hygiene and Tropical Medicine Ethics committee (21 July 2009).

Results

Baseline characteristics

A total of 3541 infants aged between 0 to 12 months were registered in the Keneba DSS between February 1974 and July 2008. Of these infants, 56 died before they reached 12 months of age. MUAC measurements taken at the age of interest (6–14 weeks) were missing for 556 (16%) infants, 125 of whom had their initial records generated before the age of 6 weeks and 431 after the age of 14 weeks. Ninety six (3%) infants were non-residents of Keneba; 13 (0.4%) infants could not be traced after recruitment (Fig. 1). A total of 2876 infants were included in the analysis (equivalent to 839 747 child–days of observation); their median age at enrolment was 61 days (interquartile range, IQR: 53–76 days). Of these infants, 2033 (71%) were recruited during the long dry season.

At recruitment, the median WFLz was 0.15 (IQR: −0.65 to 0.93) and the median MUAC was 121 mm (IQR: 114–128). Wasting (WFLz < −2) was present in 144 (5%) infants (Table 1). MUAC and WFLz both showed distributions that varied significantly by season of birth (P < 0.01) but not by decade of birth.

Forty infants died and 147 infants were censored between recruitment and 12 months of age (Fig. 1). The median values for age, MUAC, weight and length did not differ significantly between the censored and uncensored infants (P > 0.05). Of the 125 infants whose first record was generated before 6 weeks of age, 5 died before reaching the age of 12 months (Fig. 1). The proportion of infants who died increased as MUAC and WFLz decreased (χ^2 test for trend P < 0.001) (Table 1).

Predictive value

WFL*z* identified very few of the 40 infants who subsequently died. Only 3 of these 40 infants had a baseline WFL*z* < −2. WFL*z* was only significantly associated with death at values < −3, whereas MUAC categories of < 115 mm, < 110 mm and < 105 mm were associated with HR estimates of 4.5 (95% CI: 1.4–15), 9.5 (95% CI: 2.6–35) and 23 (95% CI: 4.2–122), respectively (Table 1).

Severe wasting (WFL*z* < −3) predicted death before 12 months of age with a sensitivity of 7.5% (95% CI: 2.5–20) and a specificity of 98% (95% CI: 97–99), whereas MUAC < 105 mm predicted death with a sensitivity of 20% (95% CI: 11–35) and specificity of 93% (95% CI: 92–94) (Fig. 3). The area under the ROC curve for predicting death was 0.55 (95% CI: 0.46–0.64) for WFL*z* and 0.64 (95% CI: 0.55–0.73) for MUAC (Fig. 3). Although the point estimate for MUAC was higher, this difference was not statistically significant at the conventional level ($P = 0.07$).

The cumulative attributable risk associated with values of WFL*z* < 0 within the study population was 13.0%, while that associated with a MUAC ≤ 130 mm was 51.7% (Fig. 4).

Fig. 3. **Receiver operating characteristic curve of mid-upper arm circumference (MUAC) and weight-for-length *Z score* (WFL*z*) in Gambian infants, from recruitment to 12 months of age**

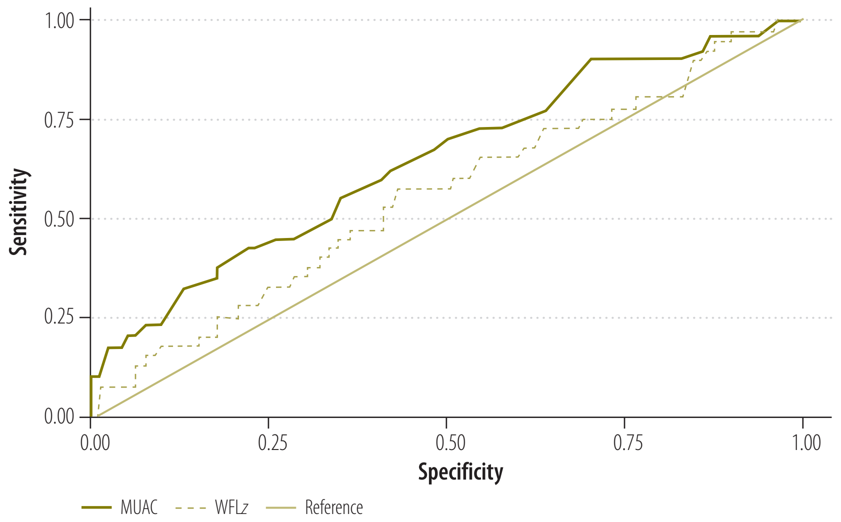
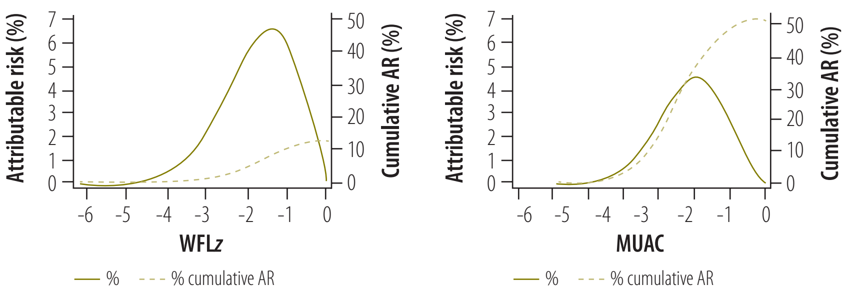


Fig. 4. **Risk of death in infancy attributable to weight-for-length *Z* score (WFL*z*) and mid-upper arm circumference (MUAC) among Gambian infants**



AR, attributable risk.

Discussion

We have shown that a single MUAC measurement in infants around the age of vaccination (6–14 weeks) has predictive value with respect to infant death. Contrarily, WFL*z* had poor predictive value with respect to infant death: the CIs of the area under the ROC curve included 0.5, which suggests that the WFL*z* values observed were not significantly different from those that would be obtained by randomly allocating children to different risk of death categories. The observed HR for MUAC < 110 mm was broadly comparable to reported pooled odds ratios for all-cause deaths associated with severe wasting among children aged less than 5 years.[38] WFL*z* identified very few of the infants who died and thus had low sensitivity for predicting infant death.

Little has been published on the use and interpretation of anthropometric measurements in infants aged less than 6 months. A recent study using data from Ghana, India and Peru reported that moderate wasting (WFL*z* < −2 but ≥ −3) observed during the first immunization visit (i.e. between weeks 6 and 10 after birth) poorly predicted death before 6 months of age.[39] Our findings are concordant with those of this study, which also show that, in the age group of infants aged 6 to 14 weeks, a WFL*z* < −3 identified a very small proportion of the infants at risk of dying. Similar findings have been reported among infants aged 0 to 12 months in the Congo.[40] Although the age range in this study was broader than ours, the finding suggests that the WFL*z* cut-offs in current use may be of little value in discriminating younger infants at higher risk of death. Several factors may explain the poor discriminatory and predictive value of WFL*z*. First, it is possible that WFL*z* is inaccurately or unreliably measured in infants aged less than 6 months.[22,41] Second, WFL*z* is a very indirect measure of muscle and fat mass, unlike MUAC. These body compartments, and in particular muscle mass, seem important for health and survival.[42,43]

Currently, MUAC is not being measured in infants aged less than 6 months because of lack of evidence to direct its interpretation. In children aged 6 to 60 months, MUAC shows a known bias towards identifying younger and smaller infants as malnourished[44] and the rapid growth experienced by younger infants may make it difficult to establish an appropriate single MUAC cut-off value. In this study we minimized the effects of this age-selection bias by adjusting the hazard model for the infant's exact age in days and by limiting the analysis to an age band of 6 to 14 weeks, which coincides with the age range for routine infant vaccination. The idea was to use a selection criterion that would enhance the operability of our findings within the existing health system. In the case of infants who do not access routine vaccination services, MUAC could also be measured routinely as part of active community-based screening. However, because of improved vaccination coverage throughout Africa, the proportion of infants likely to be missed using this criterion is expected to be small.[23] Further studies exploring the use of MUAC to assess the nutritional status of infants aged less than 6 months are recommended to gather evidence from which to determine the optimum age bands for its use.

A potential MUAC threshold

In our analysis, we focused on investigating the sensitivity, specificity and positive predictive value of MUAC and had intended to use the findings as criteria for selecting an appropriate threshold for this measure, as suggested by Myatt et al.[17] We found that most deaths in the study population were associated with MUAC below a threshold of 130 mm. Specifically, 36% of the deaths in infancy would hypothetically be prevented if MUAC among infants aged 6 to 14 weeks were sustained above a cut-off of 110 mm, whereas practically no deaths would be prevented if WFL*z* were sustained above −3.

It makes sense to use a MUAC value that identifies infants at high risk of death but likely to benefit from intervention. Thus, the best MUAC cut-off depends on the potential effectiveness and cost-effectiveness of any intervention that might be applied.[17] In the absence of these data, information on predictive and discriminatory value are used instead to define cut-offs. Although in our study infants aged 6 to 14 weeks with MUAC < 115 mm had a fourfold greater risk of dying than those with MUAC ≥ 130 mm, this 115 mm cut-off identified about one fourth (27%) of the infants in the sample and hence lacks specificity (Table 1). This finding does highlight, however, the need to improve nutrition in the general population.

From our data, a MUAC cut-off of less than 105 mm would be highly specific in that it would select 7% of the total infant sample, specifically the fraction with a dramatically elevated risk of death (HR = 23). These infants are probably too sick to survive even when treated or require a highly intensive and invasive therapeutic intervention to be rehabilitated. On the other hand, a MUAC cut-off of 110 mm is less specific and would select 14% of the target population, i.e. the fraction having a risk of death nearly 10 times higher than well-nourished infants (HR = 9.5). This 110 mm cut-off may identify a group of infants who, if not acutely ill, could probably benefit from home-based preventive, low-intensity interventions focused on breastfeeding, micronutrient supplementation, good hygiene and prevention of infections. Thus, the choice of a MUAC cut-off value depends on the type of interventions available. The selected cut-off should be tested in practice and verified across various settings.

Study strengths and limitations

To examine the relationship between MUAC in early infancy and death in the first year of life we relied on data from a well-maintained and well-resourced surveillance system with good anthropometric data covering four decades. This data source lends strength to our findings. However, one important limitation of our study is that only 40 deaths were observed among the 2876 infants who were followed up to 12 months of age. This very low death rate, which has been previously noted in Keneba, is believed to result from direct and indirect exposure to improved health interventions in this DSS setting, where research has been conducted for many years.[25] Thus, the presence of the DSS might have undermined our ability to detect the association between anthropometric measures and survival. It may be impossible to find another prospective cohort for validating MUAC cut-offs, but historical data from older cohorts is feasible and can also serve the purpose.

Another important limitation is that the direct causes of death of the infants could not be ascertained because they had not been systematically registered in the DSS. While accurate cause-of-death data would be of considerable interest, collecting it is not easy. Verbal autopsy methods have very poor sensitivity for the most common causes of death in the age group we studied, including pneumonia and gastroenteritis.[45,46] Importantly, the studies that have sought to establish anthropometric criteria for malnutrition in children aged 6 to 60 months have relied on estimates of all-cause mortality rather than cause-specific mortality.[13,14]

Conclusion

In infants aged 6 to 14 weeks, which is the age of routine vaccination, MUAC below 115 mm identifies infants more likely to die before the age of one year than well-nourished infants. MUAC can be accurately, affordably and reliably measured with ease, and we recommend measuring it during routine infant vaccination. In the absence of data on the effectiveness of interventions for the management of malnourished infants in a given context, we suggest using a MUAC cut-off of 110 mm to identify infants with a markedly increased risk of death. Research on appropriate clinical guidelines for the treatment of severe acute malnutrition in infants aged less than 6 months is needed to support effective interventions. ■

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Competing interests: None declared.

ملخص

قياس محيط أعلى الذراع في سن التطعيم الروتيني للرضع لتحديد المعرضين لخطر وفاة مرتفع: دراسة أترابية استعادية في غامبيا

الغرض تحديد القيمة التنبؤية للوفاة قبل 12 شهراً من العمر عن طريق قياس محيط أعلى الذراع (MUAC) وقياس الانحراف عن المعايير بالنسبة للوزن مقابل الطول (WFLz).

الطريقة تم إجراء تحليل أترابي استعادي للرضع الذين يعيشون في كينيبا، في ريف غامبيا. وتم الحصول على القياسات البشرية من سجلات نظام الترصد الديمغرافي للرضع المسجلين فيما بين شباط/ فبراير 1974 وتموز/ يوليو 2008 الذين تم تسجيل قياس محيط أعلى الذراع وقياس الانحراف عن المعايير بالنسبة للوزن مقابل الطول بالنسبة لهم فيما بين الأسبوع السادس إلى الرابع عشر من العمر، وتسجيل الحالة الحيوية لهم مرة أخرى على الأقل. وتم تقدير نسب المخاطر والنسب المعزوة إلى السكان والمناطق تحت منحنيات خصائص تشغيل المستقبل (ROC) من أجل تقييم القيمة التنبؤية للوفاة في سن الرضاع المتصلة بقياس محيط أعلى الذراع وقياس الانحراف عن المعايير بالنسبة للوزن مقابل الطول.

النتائج من إجمالي 2876 رضيعاً تضمنهم التحليل، توفي 40 رضيعاً قبل سن 12 شهراً. وكانت نسبة المخاطر للوفاة في هذه الفئة مقابل الرضع الذين يحصلون على تغذية جيدة 5.8 (فاصل ثقة 95٪، فاصل الثقة: 1.6 إلى 21) بالنسبة لمن يزيد قياس الانحراف عن المعايير بالنسبة للوزن مقابل الطول عن 0 إلى 3. وكانت نسب المخاطر لمن يقل لديهم قياس محيط أعلى الذراع عن عتبات 115 مم، و110 مم، و105 مم 4.5 (فاصل ثقة 95 ٪، فاصل الثقة: 2.6 إلى 35) و23 (فاصل ثقة 95 ٪، فاصل الثقة: 4.2 إلى 122)، على التوالي. وكانت النسب المعزوة لقياس محيط أعلى الذراع الأقل من 130 مم وقياس الانحراف عن المعايير بالنسبة للوزن مقابل الطول الأقل من 0 هو 51 ٪ و13 ٪، على التوالي. وكانت المناطق تحت منحنى خصائص تشغيل المستقبل الخاصة بالوفاة في سن الرضاعة 0.55 (فاصل ثقة 95 ٪، فاصَل الثقة: 0.46 إلى 0.64) بالنسبة لقياس الانحراف عن المعايير بالنسبة للوزن مقابل الطول و0.64 (فاصل ثقة 95 ٪، فاصل الثقة: 0.55 إلى 0.73) بالنسبة لقياس محيط أعلى الذراع.

الاستنتاج أظهر قياس محيط أعلى الذراع غير المصحح أداءً جيداً بين الرضع الذين تتراوح أعمارهم ما بين 6 إلى 14 أسبوعاً في تحديد الرضع المعرضين خطر وفاة مرتفع.

摘要

婴儿常规疫苗接种年龄的中上臂围用以确定高死亡风险婴儿：冈比亚回顾性定群研究

目的 确定年龄未满12 个月的中上臂围（MUAC）和身长别体重Z分值（WFLz）的死亡预测值。

方法 对生活在冈比亚Keneba农村地区的婴儿进行回顾性定群分析。从人口监测系统中在1974 年2 月至2008 年7 月间登记并在6-14 周记录了MUAC和WFLz且至少记录一次以上病危状况的婴儿的记录中获得人体测量值。估算危险比（HR）、人口归因分值和受试者工作特征（ROC）曲线下的面积，以评估在婴儿期的MUAC和WFLz死亡预测值。

结果 在纳入分析的2876 名婴儿中，40 例未满12 个月死亡。WFLz<-3 的这个组与营养良好婴儿比较的死亡HR为5.8（95% 可信区间，CI：1.6-21）。MUAC在阈值115 毫米、110 毫米和105 毫米以下的HR分别为4.5（95% CI：1.4-15）、9.5（95% CI：2.6-35）和23（95% CI：4.2-122）。MUAC<130 毫米和WFLz <0 的归因分值分别为51%和13%。婴儿期死亡的ROC曲线下的面积，WFLz为 0.55（95% CI：0.46 至 0.64），MUAC为0.64（95% CI：0.55 至0.73）。

结论 在年龄6 至14 周的婴儿中，未经调整的MUAC在确定处于更高死亡风险的婴儿方面显示出良好的性能。

Résumé

Circonférence du bras à mi-hauteur à l'âge de la vaccination systématique des nourrissons pour identifier les enfants dont le risque de décès est élevé: une étude de cohorte rétrospective en Gambie

Objectif Déterminer la valeur prédictive de décès avant l'âge de 12 mois sur la base de la circonférence du bras à mi-hauteur (ou périmètre brachial, soit PB) et du score centré réduit poids-pour-taille (WFL*z*).

Méthodes Une analyse de cohorte rétrospective a été effectuée sur des nourrissons vivant à Keneba, dans la Gambie rurale. Les mesures anthropométriques ont été extraites des dossiers du système de surveillance démographique pour les nourrissons inscrits entre février 1974 et juillet 2008, dont le PB et le WFL*z* avaient été enregistrés entre 6 et 14 semaines, et dont le statut vital avait été enregistré au moins une fois par la suite. Les ratios de risque (RR), les fractions étiologiques du risque et les zones sous les courbes de caractéristique de fonctionnement du récepteur (ROC) ont été estimés pour évaluer la valeur du périmètre brachial et du WFL*z* afin de prédire le décès des nourrissons.

Résultats Sur 2 876 nourrissons inclus dans l'analyse, 40 sont morts avant l'âge de 12 mois. Le RR de décès dans ce groupe, par rapport aux nourrissons bien nourris était de 5,8 (intervalle de confiance de 95%, IC: 1,6 à 21) pour un WFL*z* < -3. Les RR des PB en dessous des seuils de 115 mm, 110 mm et 105 mm étaient de 4,5 (IC de 95%: 1,4 à 15), 9,5 (IC de 95%: 2,6 à 35) et 23 (IC de 95%: 4,2 à 122), respectivement. Les fractions étiologiques du risque pour un PB < 130 mm et un WFL*z* < 0 étaient de 51% et 13%, respectivement. Les zones sous la courbe ROC pour le décès en bas âge étaient respectivement de 0,55 (IC de 95%: 0,46 à 0,64) et de 0,64 pour le WFL*z* (IC de 95%: 0,55 à 0,73) et pour le PB.

Conclusion Parmi les nourrissons âgés de 6 à 14 semaines, un PB non ajusté s'est révélé performant afin d'identifier les nourrissons dont le risque de décès est accru.

Резюме

Определение младенцев с повышенным риском смертности при измерении окружности середины плеча в возрасте плановой вакцинации: ретроспективное когортное исследование в Гамбии

Цель Определить прогностический уровень младенческой (в возрасте до 12 месяцев) смертности измерения окружности середины плеча (ОСП) и расчета индекса массы тела Z-score (ИМТ).

Методы Был проведен ретроспективный когортный анализ младенцев в Кенебе, сельской местности Гамбии. Антропометрические данные были получены на основе результатов системы демографического мониторинга новорожденных, зарегистрированных в период с февраля 1974 года по июль 2008 года, у которых проводилось измерение ОСП и расчет ИМТ в возрасте 6-14 недель и имелись результаты обследования состояния здоровья, проводившегося повторно. Для определения прогностического уровня младенческой смертности измерения ОСП и расчета ИМТ были проанализированы отношения рисков (ОР), площади и добавочные доли популяционного риска под графиком зависимости чувствительности от частоты ложно положительных заключений (ROC-кривая).

Результаты Из 2876 младенцев, включенных в анализ, 40 скончались в возрасте до 12 месяцев. ОР смертности в этой группе по сравнению с младенцами, имевшими полноценное питание, составил 5,8 (95% доверительный интервал, ДИ: 1,6-21) для ИМТ < -3. ОР для ОСП ниже порогового значения 115 мм, 110 мм и 105 мм составил 4,5 (95% ДИ: 1,4-15), 9,5 (95% ДИ: 2,6-35) и 23 (95% ДИ: 4,2-122) соответственно. Добавочные доли популяционного риска для ОСП < 130 мм и ИМТ < 0 составили 51% и 13% соответственно. Площади под ROC-кривой младенческой смертности составили 0,55 (95% ДИ: от 0,46 до 0,64) для ИМТ и 0,64 (95% ДИ: от 0,55 до 0,73) для ОСП.

Вывод Среди младенцев в возрасте от 6 до 14 недель нескорректированные показатели ОСП оказались действенными в определении младенцев с повышенным риском смертности.

Resumen

El perímetro braquial a la edad de la vacunación infantil rutinaria para identificar a los lactantes con un riesgo de muerte elevado: un estudio de cohorte retrospectivo en Gambia

Objetivo Determinar el valor diagnóstico de la muerte antes de los 12 meses de edad del perímetro braquial y de la puntuación Z de peso para la talla.

Métodos Se llevó a cabo un análisis de cohorte retrospectivo de los lactantes residentes en Keneba, una zona rural de Gambia. Se obtuvieron las medidas antropométricas de los archivos del sistema de vigilancia demográfica para lactantes registrados entre febrero de 1974 y julio del 2008 a los que se había medido el perímetro braquial y la puntuación Z de peso para la talla cuando tenían entre 6 y 14 semanas de edad y cuyo estado vital se registró al menos una vez más. Se calcularon los índices de peligrosidad, las fracciones atribuibles a la población y las áreas con curvas de la característica operativa del receptor (ROC) para evaluar el valor diagnóstico de la muerte en lactantes del perímetro braquial y la puntuación Z de peso para la talla.

Resultados De los 2876 lactantes incluidos en el análisis, 40 fallecieron antes de alcanzar los 12 meses de edad. El índice de peligrosidad de este grupo comparado con el de lactantes bien alimentados fue del 5,8 (intervalo de confianza del 95%, IC: 1,6–21) para una puntuación Z de peso para la talla < −3. El índice de peligrosidad para el perímetro braquial por debajo de los umbrales de 115 mm, 110 mm y 105 mm fue del 4,5% (95% IC: 1,4–15), 9,5 (95% IC: 2,6-35) y 23 (95% IC: 4,2–122). Las fracciones atribuibles para un perímetro braquial inferior a 130 mm y una puntuación Z de peso para la talla inferior a 0 fueron del 51% y del 13%, respectivamente. Los resultados en las áreas bajo influencia de la curva ROC para la muerte infantil fueron 0,55 (95% IC: 0,46 a 0,64) para la puntuación Z de peso para la talla y 0,64 (95% IC: 0,55 a 0,73) para el perímetro braquial.

Conclusión El perímetro braquial no ajustado mostró resultados positivos para la identificación de lactantes de entre 6 y 14 semanas de edad con un riesgo de muerte superior.

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