

Risk factors of delayed developmental milestones among infants attending RCH clinics in Dodoma region: A cross-sectional study

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Abstract

Background: Delayed Developmental Milestones are defined as slow to attain typical developmental milestones in one or more developmental areas. This study aimed to assess risk factors of delayed developmental milestones among infants in the Dodoma Region.

Methods: We conducted a health facility-based cross-sectional descriptive study using the pathways developmental screening tool. A total of 262 mothers and their children were enrolled, and the study population consisted of neonates delivered at the study sites during the study period. Three data collection methods were utilized to obtain information for this study: observation, interviewer-administered questionnaires, and documentary review. Ethical approval was obtained from the Ethical Review Board of the University of Dodoma SAS version 9.4, which was used for data analysis. The association between developmental status and factors was assessed using Chi-square and binomial logistic regression.

Results: Notably, infants born with birth asphyxia were more likely three times to develop delayed developmental milestones as opposed to those without birth asphyxia [adjusted risk ratio =3.22, 95%, [1.97, 5.46], probability value= <.0001]. Birth weight was significantly associated with delayed developmental milestones; infants who were born with a birth weight of ≥ 4000 gm had more risk of developing delayed developmental milestones compared to those with a birth weight of 2500-3999gm [adjusted risk ratio 0.48, 95%, [0.26, 0.92], probability value = 0.0256]. Regarding mode of delivery, the risk of developing delayed developmental milestones was less among infants born via caesarean section compared to those who were born via spontaneous vaginal delivery [adjusted risk ratio 0.47[0.18, 0.99], probability value = 0.0461].

Conclusion: Delayed developmental milestones are a burden in developing countries. The risk factors are known, and they are based on the individual to the community level; birth asphyxia was identified as a possible risk factor that has been reported in many studies and has an impact on children's development.

Keywords: Delayed developmental milestones, birth asphyxia, infants, factors, Apgar score

Introduction

Delayed Developmental Milestones (DDM) are defined as slow to attain or not reaching normal developmental milestones in one or more developmental areas such as

(communication, sensory-motor, personal-social, cognitive, vision & hearing and activities in daily living) in the expected ways for a child's age (Balica et al., 2014; Nguetack et al., 2015; Habibullah et al., 2020; WHO, n.d.).

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The prevalence of DDM is increasing worldwide over time (Kim., 2022), and more than 250 million children below five years of age do not reach their expected milestones due to this condition (WHO & UNICEF, 2017). The rate of DDM increased from 8% to 15% from 2003 to 2017; this is more than 4 times (from 0.6 to 2.5). boys had a higher incidence than girls. The gap increased from 19.1% to 31.4% (Kim., 2022). According to (Gil et al., 2020) the incidence of DDM varied by region, ranging from 10% in Europe and Central Asia to 42% in West and Central Africa (Padayachee & Ballot, 2013; Shirima, 2013; Oluwafemi et al., 2018; Abdel et al., 2018; Sunderajan & Kanhere, 2020; Saleem et al., 2020). The situation is worse for children born under a variation of medical conditions, including BA (WHO, 2011; Shaahmadi et al., 2015; Boskabadi et al., 2015 ; Lee et al., 2019 ; Lancaster et al., 2018). Delayed developmental milestones was prevalent in African nations in the range of 10% to 38.9%. Mostly severity of these disabilities were noted among infants with neurodevelopmental delay in three or four domains (Namazzi et al., 2019; Meshesha et al., 2020). A study in Uganda showed that of 62 infants with DDM, nine (14.5%) developed long-term disability (Namazzi et al., 2019). Another study in Malawi revealed that 109 out of 933 (11.7%) children were regarded as having DDM, 41 (4.4%) in “language” and 77 (8.3%) in “social” domains (Murphy et al., 2020).

In Tanzania, there has been an upsurge in morbidity among children, such as DDM. (Sepeku & Kohi, 2011; Mangu et al., 2021) the prevalence rate of DDM was 2.3%; among children aged five years and above, overall 7.8% of females had DDM compared to 5.7% of males (Murphy et al., 2020). The frequency of newborns with cognitive developmental delay, on the other hand, was found to be 12.3% in a Dar es Salaam (Shirima., 2013). Studies

conducted in Morogoro and Manyara also revealed that the main factors of DDM in cognitive, communication and motor domains were poverty malnutrition and inadequate skills among health care providers in primary health care level (Sudfeld et al., 2015; Ribe et al., 2018; MOHCDGEC., 2022).

Higher understanding of key factors associated with DDM is therefore mandatory and to make sure that all children may achieve their normal developmental milestones within expected time. Children who are exposed to multiple risk factors have a greater chance of having DDM (Ann et al., 2019; Kantar, 2020). However, very little of this work has been done in developing countries like Tanzania, where there are multiple factors including medical, physical, psychosocial, and environmental factors to interact in complex ways and to which children may be at higher risk in different ways.

There is lack of data from Tanzania that widely examine the factors associated with DDM among children. Even though recently there have been some studies examining risk factors for development (Abdel et al., 2018), Child development is one of the transformative agenda to 2030, Sustainable Development Goal (SDG) 4 states that all children should have the equal chance to reach their full developmental potentials (Gil et al., 2020; UNICEF, 2018). Because of inadequate data directly assessing these factors in developing countries, therefore there is a need to conduct the study on the risk factors of DDM among infants in Dodoma region, to raise our understanding about the prominent risk factors leading to DDM particularly in low income countries (Ann et al., 2019). Therefore, this study aimed to assess the range of risk factors of DDM among infants in Dodoma region.

Methods and materials

Study design and population; This was a health facility-based cross-sectional study to determine factors associated with DDM in infants who attended at Bahi, Mundemu, Mlali, Ugogoni, Hombolo and Makole health centers, St Gemma districts designated, Kongwa and Bahi ditricks hospitals. The data was collected from September to December 2022. As per census 2022, the total population for Dodoma region was 2,083,588 (NBS, 2022). The Region has a total of 12 hospitals. Eight of these hospitals are Government owned. These are

Inclusion and exclusion criteria

Children of 9-12 months of age residing continually in the study area for the last three months before data collection and the infants who were born and attended RCH clinical at the study sites were involved. Infants with congenital abnormality, metabolic disorders, infants with parents who did not wish to participate in the study, children below 9 months of age and children who were not born in the study sites were excluded.

Sample size and sampling procedure.

Based on 19 % the prevalence of suspected delayed developmental milestones in a similar study in low middle income countries (Gil et al., Among 7 districts in Dodoma region three were chosen for this study by using simple random sampling. These were Dodoma City Council, Bahi and Kongwa districts. Total of 9 health care facilities were involved in the study. The selected health care facilities were, Kongwa, Bahi Districts Hospitals and St Gemma Districts Designated Hospital. The health centers form Dodoma City Council were Makole and

Data collection and assessment

A structured questionnaire which was adopted from various African nations (Ilah et al., 2015; Fauste & Olive, 2017; Muluneh, & Denis, 2019). Were used to collect the following information: (mothers) age in years, level of education, marital status, Occupation tribe, body weight,

Dodoma Regional Referral Hospital (DRRH), Benjamin Mkapa Hospital (BMH), Mirembe National Mental Health Hospital, Kondoa, Kongwa and Mpwapwa, Bahi and Chemba, Districts Hospitals and 2 are private hospitals; St. Gemma Hospital owned by Roman Catholic Church and Mvumi Mission Hospital owned by the Anglican Church. There are 26 health centers owned by the government and 6 health centers privately owned. There are 284 dispensaries in the region.

2020) 95% confidence interval (CI), 5% relative error, design effect 2 and 5% non-response rate, the minimum sample came to be 262.

$$\frac{Z^2 \alpha/2 P(1-P)}{e^2}$$

Where:

n = Minimum sample size

Z = Standard normal deviation of 1.96 corresponding to 95% confidence interval.

P= The proportion of suspected DDM in low middle income countries which is 19%

e= Degree of accuracy of the results, was 0.05.

$$\frac{1.96^2 \times 0.19 \times (1-0.19)}{0.05^2} = 236.488896 \approx 237$$

Adding attrition rate of 10% we get 261. Hence the minimum sample size was 261 \approx 262.

Hombolo, from Kongwa district were Ugogoni and Mlali health centers and from Bahi were Mundemu and Bahi health center. Infants from each health care facility were chosen randomly. Three methods of data collection were utilized to obtain information for this study, the observation, interviewer-administered questionnaire and documentary review.

gestational age, sex of a child antenatal care attendance, mode of delivery, Bad obstetric history and complications during labor and delivery. Developmental delay in children was assessed by using Pathways Developmental Screening Tool (PDST). The tool was developed by Paediatric Specialist with the intention of

monitoring any noticeable delays, collecting data from parents, and referring all suspected cases for early detection and treatment. (Overview of Pediatric Therapy, 2022), the tool was validated and standardized by American Academy of Paediatrics (AAP), and it has 97 items in total, with four domains: motor, sensory, communication, and feeding domains. In this tool delayed developmental milestones were measured in binary scale on

whether a child achieved normal developmental milestones. If a child achieved any items within each domain was given a score of 1 and failure to achieve was scored 0. All scores were summed up, if the child passed a total of 3 items in each domain was regarded as having normal developmental milestones if scores less than that was regarded as having delayed developmental milestones.

Data analysis

Data was entered to statistical package for social science (SPSS) version 25, Data were cleaned and checked for errors to enhance the reliability and consistency, this was done before analysis Statistical Analysis System (SAS) version 9.4 was used for the data analysis and significance of all statistical tests was determined at 5% level. The results of the model were presented in the form of a regression parameter estimate and estimated risk ratios (RR). The estimated RR shows the increase or decrease in the risk of the outcome at a given level of the independent variable compared to those in the reference category. An estimate of $RR > 1$ indicates that the risk of having DDM at a given level of the independent variable is greater than that for the reference category. Similarly, an estimate of $RR < 1$ specifies that the chance of having DDM at a given level of independent variable is less than that for the reference category. Moreover, adjusted risk ratio (ARR), 95% confidence interval (CI) and probability value (p value) were presented.

Results

Demographic characteristics of study participants among non-exposed and exposed neonates.

The mothers' ages ranged from 18 to 44 years, with a mean age of 26.59 ± 6.63 , while the

Ethical considerations

Ethical clearance was attained from the University of Dodoma Ethical Review Board with a Ref no (MA.84/261/141/134). Permission was sought from the Vice Chancellor of the University of Dodoma, Regional Administrative Secretary of Dodoma Region. On the day verbal consent was obtained from each participant to get involved in the study. The participants were informed about the purpose of the study and the duration, how data will be collected and that they were involved voluntarily. Ethical approval from the ethical committee has been acquired September 2022.

The participants were informed about the purpose of the study and the duration, how data will be collected and that they were involved voluntarily. Participants were also informed that they were free to withdraw from studying at any time if they wished to. Participants were assured of anonymity that their names would not be included in the questionnaires.

infants had an average birth weight of 3.227 ± 0.55 . Out of all the mothers, 165 were below the age of 25, In terms of gender distribution among the children in the study, more than half were female (148)56.47% and the rest were male. Concerning birth weight, the majority (190 or 59.94%) were born with birth weight of less than 3000g, (Table 1).

Table 1: Demographic Characteristics of the Study Participants among unexposed and exposed (N=262)

Variable	Frequency	Percentage
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Age		
<25	125	47.71
26-35	105	40.08
>35	32	12.21
Education		
Not attended	47	17.94
Primary	123	46.95
Secondary	66	25.19
Above secondary	26	9.92
Place of resident		
Urban	141	53.82
Rural	121	46.18
Marital status		
Married	241	91.98
Single	21	8.02
Occupation		
Famer	105	40.08
Formal job	157	59.92
Tribe		
Gogo	120	45.80
Rangi	53	20.23
Others	89	33.97
Birth weight of a child		
<3000	156	59.54
=>3999	106	40.46
UPGAR score at 5min		
<7	178	67.96
7+	84	32.06
Sex of child		
Male	114	43.51
Female	148	56.49

Prevalence of delayed developmental milestones

Out of the 262 infants, 45 infants had delayed developmental milestones giving a prevalence of 17.18% while 217 (82.82%) infants had no DDM.

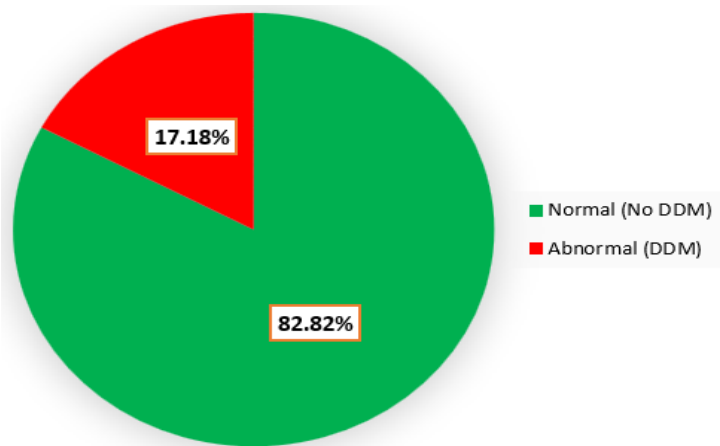


Figure 1: The prevalence of DDM among respondents

Risk factors associated with DDM by using tool 2 PDST

Binomial logistic regression was used to assess other factors associated with DDM among infants. The results showed a strong relationship between DDM and BA ($p= 0.0001$), and infants who were born with BA had higher risks 3.22 of developing DDM compared to those without BA [RR=2.88, 95%, [1.69, 4.91] $p= 0.0001$]. Other risk factor associated with DDM was birth weight. Regarding birth weight results showed that infants who had birth weight of $\geq 4000\text{gm}$ had 1.76 more risk of developing DDM than those with birth weight of 2500-3999gm [RR= 1.76, 95% [1.04, 3.00], p value= 0.0365. Other factors such as occupation, place of residence, marital status, mode of delivery, sex of a child and gestational age were not significantly associated with DDM. More details are found in Table 2.

In multiple logistic regression infants born with BA were more likely three times to develop DDM as opposed to those without BA [ARR =3.22, 95%, [1.97, 5.46], p value= <.0001]. Birth weight was significantly associated with DDM, infants who were born with birth weight of $\geq 4000\text{gm}$ had more risk of developing DDM compared to those with birth weight of 2500-3999gm [ARR 0.48, 95%, [0.26, 0.92], p value = 0.0256]. Regarding mode of delivery, the risk of developing DDM among infants was less among infants born via caesarean section compared to those who were born via spontaneous vaginal delivery [ARR 0.47[0.18, 0.99], p value = 0.0461]. Other factors such as occupation, place of residence, marital status, sex of a child and gestational age were not significantly associated with DDM. More details found in table 2.

Table 2: Factors Associated with DDM 12 Months Using PDST (n=262)

Variable	Normal DDM) 217(82.82) n (%)	(No Abnormal (DDM) 45(17.18) n (%)	Unadjusted analysis RR [95%CI]	p-value	Adjusted analysis ARR [95%CI]	p-value
BA						
Normal (No BA)	159(89.33)	19(10.67)	ref		ref	
Abnormal (BA)	58(69.05)	26(30.95)	2.88[1.69, 4.91]	0.0001	3.22[1.97, 5.46]	<.0001
Occupation						
Farmer	91(86.67)	14(13.33)	ref		ref	
Formal job	126(80.25)	31(19.75)	1.46[0.82, 2.61]	0.1851	1.54[0.87, 2.74]	0.1367

Place of residence						
Urban	118(82.52)	25(17.48)	ref			
Rural	104(83.87)	20(16.13)	0.92[0.54, 1.58]	0.7685		
Marital status						
Married	202(83.82)	25(17.73)	ref			
Single	15(71.43)	6(28.57)	1.77[0.85, 3.68]	0.1294	1.53[0.56, 3.17]	0.2493
Mode of delivery						
SVD	163(81.09)	38(18.91)	ref		ref	
Caesarean section	54(88.52)	7(11.48)	0.61[0.29, 1.29]	0.1941	0.47[0.18, 0.99]	0.0461
Sex of the child						
Male	92(80.70)	22(19.30)	1.05[0.93, 1.17]	0.4311		
Female	125(84.46)	23(15.54)	ref			
Birth weight						
2500-3999gm	95(89.62)	11(10.38)	ref		ref	
4000+gm	122(78.21)	34(21.79)	1.76[1.04, 3.00]	0.0365	1.48[1.26, 2.92]	0.0256
GA						
	37(16.44)	188(83.56)	ref			
	8(21.62)	29(78.38)	0.93[0.78, 1.12]	0.4834		
Presentation of the foetus						
	44(17.81)	203(82.19)	ref			
	1(6.67)	14(93.33)	1.14[0.98, 1.32]	0.2103		

Discussion

The current study indicated that the leading risk factor for DDM was BA, this is the main predictor for the occurrence of DDM which can lead to severe consequences of permanent disabilities. The findings showed that the children who were born with BA were at higher risks of having DDM compared to those who were born without BA.

The prevalence of BA was high in study area the risk factors are known, The similar findings were observed by Halloran, Mwakyusa, Nguetack, Oluwafemi and Adeniyi.(Halloran et al., 2009; Mwakyusa et al., 2009; Nguetack et al., 2015; Oluwafemi et al., 2018; Adeniyi; Asinobia & Idowua, 2022) This problem is high in many developing countries than developed countries due limited obstetric care, lack of health care facilities, social cultural norms, low literacy levels and shortage of health care workers (Workineh et al., 2020)

Demographic factors like birth weight, place of residence, sex of a child, mode of

delivery etc. were regarded as other factors for the occurrence of DDM in this study. These factors have both positive and negative effect on child development. The similar study form India observed that socioeconomic status, parenting, social environment and interactions as a the strongest risks for poor cognitive performance in children (Zhang et al., 2020). Therefore, therefore is important to consider the aetiology and risk factors in the evaluation of morbidity in these children (Vafae-Shahi et al., 2020). These could show the importance of these networks surrounding the children, safeguarding the wellbeing and the optimal child growth.

Gender was also noted as one of the prominent factor for occurrence of DDM, it was observed that majority of the study participants were female 179 (56.47%) compared to male 138 (43.53%) (Gemuhay et al., 2023), but it has been noted that male gender is at higher risk 45(32.61%) than female 56(31.28%). This finding concur with the study

conducted in Nigeria and Pakistan (Oluwafemi et al., 2018), (Aghai et al., 2020) these studies reported that male gender was significantly associated with poor neonatal outcome (OR= 3.24, 95% CI = 1.02-10.35). Gender has been found to be a main predictor of BA because boys are more vulnerable than girls and they tend to have poor neonatal outcome, boys are heavier than girls at birth this contribute to higher rates of complications like BA.

Body weight was also regarded as one of the prominent features for the occurrence of BA (Gemuhay et al., 2023). A large proportion of asphyxiated babies were those who had birth weight of more than 3999 compared to those without abnormal body weight. These findings are similar to the study conducted in Ethiopia where 83 (23.2%) neonates who were overweight had DDM (Admasu et al., 2022). This is because any difficulties like overweight can create abnormal heart rhythms that cause oxygen deprivation to baby which can lead to HIE.

This study showed that mode of delivery was one of the risk factors for DDM. Most of the infants were born through spontaneous vaginal delivery and this mode of delivery was considered as one of the factors associated with DDM, infants who were born through caesarean section were less likely to have DDM. This results contradict the findings of the study conducted in China (Zhou et al., 2019) the prevalence of DDM was 23.4% in the cesarean section group, compared with 21.3% in the vaginal delivered group, yet without

statistical difference ($p < 0.05$). This portrays that there are some delays in decision making among health care providers to do caesarean section when it is necessary. According to (Waniala et al., 2020) caesarean section is considered a curse, marriage-breaker, misfortune, money-maker and a sign of incompetent health workers, and being for the lazy women and the rich civil servants among some communities.

It is interesting to note that antenatal care attendance, occupation, place of residence, mode of delivery, sex of a child and gestational age were not significantly associated with DDM. These findings are comparable to WHO, which reported that women who attended ANC might have little or no effect on perinatal mortality (2 trials, 713 women; RR: 0.77, 95% CI:0.17–3.48) (Tongkumchum P, 2005; WHO, 2016).

Majority of infants who developed DDM were BA survivors, so those children are likely to develop long-term disabilities (Eblovi et al., 2017; Shaahmadi et al., 2015; Abdel et al., 2018). BA has serious long-term impacts and causes potentially fatal condition among infants in developing countries. Its effects were also observed by Ahearne that majority of these children end up with irreversible permanent disabilities which burdens the child health and wellbeing (Ahearne, 2016). Therefore comprehensive care should be given to women of child bearing age before and after pregnancy to reduce long-term effects (Admasu et al., 2022).

Conclusion and recommendations

The DDM is a burden in developing countries, the risk factors are known and they base from individual to community level. These factors are modifiable and needs to be addressed accordingly, when developing and implementing policies for reproductive and child health care, in the aspects of preconception, pregnancy, and early childhood in the context of families and communities. The findings of this study can be applied in developing countries, but they might not apply in developed countries due to the differences in social structures, health care systems, and availability of resources between those nations. It is therefore recommended that health care facilities should include physiotherapy, occupational therapy, speech and language therapy, and early special education because these are frequently beneficial for children with DDM. It is also important to use of both HIE

scoring system and Apgar score for all infants born with BA in order to identify infants who are at higher risk to develop DDM.

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Conflicts of interest

There are no conflicts of interest.

Statement of data availability

The data are available from the corresponding author upon sensible request.

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