Libyan Open University Journal of Applied Sciences (LOUJAS)
Volume 2 - Issue 1 - 2026 - Pages 512-519

Parental Awareness of Growth and Developmental Delay in Children Under Five in Tobruk, Libya: A Cross-Sectional Study

Khadeejah M.A. AL-Khurum[1], Alaa Ezzeddin al-Amami[2]
[1]Department of Pediatrics, Faculty of Medicine, University of Tobruk, Tobruk, Libya
[2]Medical Student, Faculty of Medicine,Tobruk University, Tobruk, Libya
* **Email (for reference researcher):** khadija.moftah@tu.edu.ly

وعي الوالدين بتأخر النمو والتطور لدى الأطفال دون سن الخامسة في طبرق، ليبيا: دراسة مقطعية

خديجة مفتاح الخرم[1] ، الاء عزالدين العمامي[2]
[1]قسم طب الأطفال، كلية الطب ،جامعة طبرق ، ليبيا
[2]طالبة طب، كلية الطب، جامعة طبرق، طبرق، ليبيا

Received: 15-03-2026; Accepted: 20-05-2026; Published: 02-06-2026

Abstract

Background: Early detection of childhood developmental delays (DD) relies heavily on parental vigilance and health literacy. This study assessed baseline awareness of developmental milestones and clinical red flags among parents of children under five in Tobruk, Libya, evaluating the impact of socio-demographic determinants on developmental screening outcomes.

Methods: A clinic- and community-based cross-sectional survey was conducted in Tobruk during Febuarary 2026. Using convenience sampling, a validated Arabic questionnaire was distributed to Libyan parents to evaluate socio-demographic profiles, milestone recognition (speech and gross motor), and healthcare-seeking behaviors. Data were analyzed using SPSS (Version 26.0).

Results: Among the 305 participants analyzed, mothers predominated (86.2%, n=263) and 72.1% (n=220) held university degrees. While 84.9% (n=259) were familiar with the term "developmental delay," specific knowledge varied: 54.4% (n=166) and 81.3% (n=248) correctly identified the 1-2 years expected window for speech production and independent walking, respectively. However, roughly one-third of the sample misestimated these timelines. Encouragingly, 82.0% (n=250) recognized a child's failure to respond to their name as a clinical red flag, and 80.0% (n=244) agreed that speech delays require medical evaluation. Physicians were the primary source of developmental information (41.6%, n=127), followed by family networks (24.3%) and the internet (23.6%).

Conclusion: General awareness of developmental delay is remarkably high among this educated urban demographic in Tobruk, yet specific gaps remain regarding precise milestone timelines. Public health strategies should leverage high community trust in clinicians to incorporate standardized screening into routine pediatric and vaccination visits.

Keywords: Developmental Delay, Parental Awareness, Child Development, Cross-Sectional, Tobruk, Libya, Academic Pediatric Research.

الملخص

الخلفية: يعتمد الكشف المبكر عن تأخر النمو لدى الأطفال بشكل كبير على يقظة الوالدين ومعرفتهم الصحية. هدفت هذه الدراسة إلى تقييم مستوى الوعي الأساسي بمراحل النمو والعلامات التحذيرية السريرية لدى آباء الأطفال دون سن الخامسة في طبرق، ليبيا، مع تقييم تأثير العوامل الاجتماعية والديموغرافية على نتائج فحص النمو.

المنهجية: أُجري مسح مقطعي في طبرق خلال شهر فبراير 2026، شمل عيادات ومجتمعات محلية. وباستخدام أسلوب العينة المتاحة، وُزّع استبيان عربي مُعتمَد على آباء ليبيين لتقييم خصائصهم الاجتماعية والديموغرافية، وإدراكهم لمراحل

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

النمو (النطق والمهارات الحركية الكبرى)، وسلوكياتهم في طلب الرعاية الصحية. وتم تحليل البيانات باستخدام برنامج SPSS (الإصدار 26.0)
النتائج: من بين 305 مشاركين تم تحليل بياناتهم، كانت الأمهات هنّ الغالبية (86.2%، ن=263)، و72.1% منهم (ن=220) حاصلون على شهادات جامعية. بينما كان 84.9% (ن=259) من المشاركين على دراية بمصطلح "التأخر النمائي"، تفاوتت معرفتهم به: فقد حدد 54.4% (ن=166) و81.3% (ن=248) بشكل صحيح الفترة الزمنية المتوقعة من سنة إلى سنتين لبدء النطق والمشي المستقل، على التوالي. مع ذلك، أخطأ ثلث العينة تقريبًا في تقدير هذه الفترات. ومن المشجع أن 82.0% (ن=250) اعتبروا عدم استجابة الطفل لاسمه مؤشرًا سريريًا يستدعي الانتباه، ووافق 80.0% (ن=244) على أن تأخر النطق يتطلب تقييمًا طبيًا. وكان الأطباء المصدر الرئيسي للمعلومات النمائية (41.6%، ن=127)، يليهم أفراد العائلة (24.3%) ثم الإنترنت (23.6%).
الخلاصة: يُعد الوعي العام بالتأخر النمائي مرتفعًا بشكل ملحوظ بين هذه الفئة السكانية المتعلمة في المدن بطبرق، إلا أن هناك فجوات محددة لا تزال قائمة فيما يتعلق بالجداول الزمنية الدقيقة للمراحل النمائية. ينبغي أن تستفيد استراتيجيات الصحة العامة من ثقة المجتمع الكبيرة بالأطباء لدمج الفحص المعياري في زيارات طب الأطفال والتطعيمات الروتينية.

الكلمات المفتاحية: تأخر النمو، وعي الوالدين، نمو الطفل، دراسة مقطعية، طبرق، ليبيا، البحوث الأكاديمية في طب الأطفال

INTRODUCTION

The first five years of life represent a unique and critical window characterized by rapid neurological maturation, synaptic pruning, and structural brain layout organization. During this highly intensive phase, child development unfolds dynamically across multiple interlinked domains, including gross and fine motor skills, cognition, speech/language acquisition, and socio-emotional behaviors (World Health Organization [WHO], 2022). When a child consistently fails to achieve these age-specific benchmarks or shows an ongoing divergence from normal physiological patterns, a clinical diagnosis of Developmental Delay (DD) or Global Developmental Delay (GDD) is established.

Globally, developmental disabilities affect an estimated 10% to 15% of children. This global burden is disproportionately higher in low- and middle-income countries, heavily driven by primary healthcare resource constraints, geopolitical shifts, and socioeconomic disparities across urban and rural demographics (Black et al., 2017; Sabanathan et al., 2015). Because the young brain exhibits maximum neuroplasticity and neural remodeling capability during early childhood, timely clinical intervention can radically alter the long-term cognitive trajectory, academic achievement, and eventual social integration of an affected individual (Shonkoff & Phillips, 2000;Ertem et al., 2018)

In everyday community settings, parents and mothers in particular serve as the absolute frontline observers capable of spotting early behavioral red flags and developmental deviations. Accurate parental knowledge regarding normal milestone windows is therefore critical; when parents harbor misconceptions, lack baseline info, or face deep cultural stigma, diagnosis is invariably delayed, causing children to completely miss their optimal therapeutic and rehabilitative windows (Al-Ayadhi, 2012;Zaki et al., 2020)

In Libya, the pediatric healthcare infrastructure has faced persistent structural challenges, and standardized developmental screening protocols at the primary healthcare or vaccination clinic levels are largely non-existent (Libyan Ministry of Health, 2024)While historical regional literature has occasionally addressed broader maternal-child health parameters, published data regarding explicit parental recognition of DD in eastern Libya, particularly within the municipality of Tobruk, remains virtually non-existent. Quantifying current knowledge gaps and identifying the socio-demographic determinants such as maternal education, family parity, and paternal involvement is essential for local public health planning, clinical resource allocation, and targeted community interventions (Ben-Gwirah & El-Malti, 2021; Samra & McGrath, 2019)To address this empirical gap, this cross-sectional study evaluated parental awareness of developmental delays in children under five within Tobruk, establishing baseline data to guide future community screening and educational campaigns.

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Libyan Open University Journal of Applied Sciences (LOUJAS)
Volume 2 - Issue 1 - 2026 - Pages 512-519

METHODS

Study Design and Setting

This observational cross-sectional study utilized a school- and clinic-based design within the municipality of Tobruk, Libya. Fieldwork, parental outreach, and physical data collection were systematically completed throughout Febuarary 2026. Sampling environments included primary healthcare centers, routine vaccination clinics, and pediatric outpatient departments across Tobruk, which collectively serve as the main nodes for pediatric care, physical assessments, and wellness check-ups for children under five years old.

Study Population and Sampling

Eligible participants were Libyan parents (mothers or fathers) residing in Tobruk with at least one child younger than 60 months. Enrollment was conducted via convenience sampling based on voluntary parental consent. To safeguard the integrity of the data against information bias and academic compounding, any parent with a professional medical or healthcare background (e.g., medical doctors, nurses, pharmacists, or allied health staff) was strictly excluded from participation. This essential screening step ensured that the findings truly reflected genuine community-level literacy and baseline layperson awareness.

Sample Size Calculation and Power

The target sample size was calculated using Cochran's single proportion formula, assuming a 50% baseline awareness level to maximize variance, a 95% confidence interval, and a 5% margin of error. The final analyzed cohort comprised 305 participants, providing sufficient statistical power to determine the baseline prevalence of parental awareness and investigate associated socio-demographic variables in eastern Libya.

Data Collection Instrument and Validation

Data were gathered through a structured, self-administered Arabic questionnaire, carefully adapted to fit the local dialect, cultural sensitivities, and regional phrasing. The instrument was extensively reviewed and validated in cooperation with senior pediatric consultants and the Department of Statistics. It was divided into three core sections: (1) Socio-demographic Profile (gender, age, education, parity), (2) Milestone Knowledge Tracking (speech onset and gross motor windows), and (3) Risk Factor and Clinical Intervention Awareness.

Statistical Analysis Framework

Questionnaires were coded, cleaned, and systematically managed using Statistical Package for the Social Sciences (SPSS, Version 26.0). Descriptive statistics summarized categorical data as absolute frequencies and percentages (n, %). Inferential statistics, including Chi-square tests, were mapped to examine associations between parental educational levels and milestone accuracy thresholds. Missing or omitted data points were explicitly reported within the descriptive tables to maintain absolute statistical transparency.

RESULTS

Socio-Demographic Characteristics of Participants

The final sample included 305 completed questionnaires. Respondents were overwhelmingly female; mothers comprised 86.2% (n=263) of the cohort, fathers accounted for 7.9% (n=24), and 5.9% (n=18) left the gender field unspecified within the primary data pool (Table 1).

Table 1: Distribution of Participants by Gender

Gender Category	Frequency (n)	Percentage (%)
Mothers	263	86.2%
Fathers	24	7.9%
Unspecified / Missing	18	5.9%
Total	305	100.0%

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions .of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

Age distribution showed that the largest segment belonged to the 25-35 years bracket (38.0%, n=116), followed by 36-45 years (23.9%, n=73) and those older than 45 years (23.3%, n=71). Parents younger than 25 years made up 9.2% (n=28) of the total sample (Table 2).

Table 2: Age Distribution of Respondents

Age Cohort	Frequency (n)	Percentage (%)
< 25 years	28	9.2%
25-35 years	116	38.0%
36-45 years	73	23.9%
> 45 years	71	23.3%
Missing Data	17	5.6%
Total	305	100.0%

The sample demonstrated a highly educated profile: 72.1% (n=220) held a university degree, and an additional 8.2% (n=25) had finished postgraduate studies (Table 3).

Table 3: Educational Attainment Matrix

Education Level	Frequency (n)	Percentage (%)
Primary School	6	2.0%
Secondary / Preparatory	35	11.5%
University Degree	220	72.1%
Postgraduate Studies	25	8.2%
Missing / Omitted	19	6.2%
Total	305	100.0%

Regarding family structure, 38.0% (n=116) had 2-3 children, 36.1% (n=110) had more than three children, and single-child parents constituted 14.8% (n=45) (Table 4).

Table 4: Household Parity and Child Count

Number of Children	Frequency (n)	Percentage (%)
1 Child	45	14.8%
2-3 Children	116	38.0%
> 3 Children	110	36.1%
Missing Data	34	11.1%
Total	305	100.0%

Baseline Awareness and Milestones Recognition

General awareness of the term "developmental delay" was high, with 84.9% (n=259) of respondents noting they had previously encountered the term (Table 5).

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions .of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

Table 5: Conceptual Awareness of the Term "Developmental Delay"

Response	Frequency (n)	Percentage (%)
Familiar / Heard the term	259	84.9%
Unfamiliar / Never heard	28	9.2%
Missing Response	18	5.9%
Total	305	100.0%

Specific milestone tracking revealed distinct knowledge variances. While 54.4% (n=166) of parents correctly identified the normal 1-to-2-year window for a child's first words, 34.1% (n=104) prematurely expected this milestone before 1 year of age (Table 6).

Table 6: Timeline Estimation for Speech (First Words)

Estimated Age Window	Frequency (n)	Percentage (%)
< 1 year	104	34.1%
1-2 years (Correct Window)	166	54.4%
> 2 years	10	3.5%
Missing / Unanswered	25	8.0%
Total	305	100.0%

For gross motor tracking, 81.3% (n=248) correctly identified the 1-to-2-year window as the appropriate timeframe for independent walking (Table 7).

Table 7: Timeline Estimation for Independent Walking

Estimated Age Window	Frequency (n)	Percentage (%)
< 1 year	22	7.2%
1–2 years (Correct Window)	248	81.3%
> 2 years	12	4.2%
Missing / Unanswered	23	7.3%
Total	305	100.0%

Perceptions of Clinical Red Flags and Care-Seeking Behavior

A strong consensus emerged regarding language delays, with 80.0% (n = 244) agreeing that delayed speech mandates a formal clinical evaluation (Table 8).

Table 8: Perception of Speech Delay Clinical Urgency

Parental Perception	Frequency (n)	Percentage (%)
Mandates Formal Medical Evaluation	244	80.0%
Not a Medical Issue / Normal Variation	31	10.2%
Uncertain / Don't Know	11	3.6%
Missing Data	19	6.2%
Total	305	100.0%

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions .of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

Additionally, 82.0% (n = 250) correctly recognized a child's failure to respond to their name as a critical developmental red flag (Table 9).

Table 9: Recognition of "Failure to Respond to Name" as Red Flag

Response Category	Frequency (n)	Percentage (%)
Recognized as a Red Flag	250	82.0%
Dismissed / Not a Sign	13	4.3%
Unsure / Indifferent	23	7.5%
Missing Data	19	6.2%
Total	305	100.0%

Physicians and formal healthcare providers served as the main clinical information source for 41.6% (n = 127) of the sample (Table 10).

Table 10: Primary Channels for Child Development Literacy

Information Channel	Frequency (n)	Percentage (%)
Physicians & Medical Staff	127	41.6%
Family and Peer Networks	74	24.3%
Internet & Social Platforms	72	23.6%
Miscellaneous Media	13	4.3%
Schools & Academic Staff	1	0.3%
Missing / Unspecified	18	5.9%
Total	305	100.0%

DISCUSSION

This cross-sectional study clarifies parental awareness and recognition thresholds regarding childhood developmental delays within Tobruk, Libya. Mapping out public health literacy at the municipal level is a prerequisite for structuring viable early intervention frameworks, clinical referral guidelines, and local maternal-child health services.

A prominent finding was that 84.9% of the surveyed cohort recognized the term "developmental delay." This high baseline awareness diverges from historical data collected in several developing regions, where cultural stigma or lack of formal vocabulary often masks parental recognition of DD (Bornstein & Lansford, 2015;Rao et al., 2014)However, this high recognition rate must be evaluated alongside the sample's socio-demographic composition. Over 80% of participants had completed university or postgraduate studies. This highly educated cohort represents a specific socioeconomic segment; parental education is an established predictor of elevated health literacy (Srinivasan & Al-Khusaibi, 2018; (Hasan & Al-Amri, 2023). University-educated parents, particularly mothers (who made up 86.2% of our sample), routinely use digital literature, actively monitor developmental milestones, and engage with clinical resources earlier than their less-educated peers.

Yet, despite this strong conceptual awareness, concrete knowledge gaps emerged when examining specific developmental domains. Although 54.4% and 81.3% of parents correctly identified the 1–2 years window for speech (first words) and gross motor function (independent walking), a substantial portion held skewed timelines. For example, 34.1% expected meaningful words before the first year (Valkenburg & Piotrowski, 2017). While

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions .of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

early milestone achievement occurs, unrealistic parental expectations can generate unwarranted familial anxiety or, conversely, lead to a normalization of late progression if subsequent milestones are missed (Frankenburg & Dodds, 1967).

Crucially, the data showed that parental instincts align well with objective clinical red flags. The fact that 82.0% of respondents identified a child's failure to respond to their own name as an immediate concern is highly encouraging. In pediatric diagnostics, failure to orient to one's name serves as an early behavioral biomarker for neurodevelopmental conditions, including Autism Spectrum Disorder (ASD) (Ozonoff et al., 2010; Lord et al., 2018). Furthermore, 80.0% of the sample acknowledged that speech delays warrant formal medical assessment, showing a low threshold for clinical care-seeking behaviors in Tobruk. This suggests that while parents may not know exact milestone months, they maintain a high index of suspicion toward overt communicative and behavioral deficits.

Regarding information pathways, physicians remain the premier choice (41.6%). This underscores the profound trust placed in local pediatricians and primary care clinics in Tobruk, confirming their status as the frontline defense for developmental surveillance (Al-Shamsi, 2021).Nonetheless, the internet and family circles combined accounted for nearly half of the primary information sources (23.6% and 24.3%, respectively). Relying heavily on digital media is a double-edged sword; while it grants instant access to milestone grids, it exposes families to unverified medical claims and non-standardized advice. Intriguingly, schools and educational facilities were virtually unutilized (0.3%). This exposes a major systemic disconnect, revealing that early childhood educators are underutilized in public health screening and developmental advocacy (Council on Children With Disabilities, 2020).

Several limitations qualify these findings. First, utilizing convenience sampling primarily within healthcare nodes limits generalizability to the broader population of Tobruk, especially marginalized or lower-income families facing healthcare access barriers. Second, the heavy skew toward female respondents (86.2%) precludes a balanced assessment of paternal awareness. Finally, the high proportion of university-educated individuals means these statistics likely overestimate baseline developmental literacy relative to the general public.

Limitations

This study has several limitations. First, convenience sampling was used, which may limit the representativeness of the findings. Second, the cross-sectional design prevents establishing causal relationships. Third the sampling consisted predominantly of highly educated parents, which may have overestimated awareness levels. Fourth, mothers represented most participants, resulting in limited assessment of paternal awareness. Additionally data were self-reported and may be affected by recall or social desirability bias. Finally the study was conducted only in Tobruk , limiting the generalizability of the finding to other regions of Libya.

CONCLUSION

This study demonstrates high baseline awareness of childhood developmental delays among parents in Tobruk, Libya, driven largely by an educated maternal demographic. While trust in physicians and recognition of behavioral red flags are high, specific gaps persist regarding exact milestone schedules. Public health initiatives in eastern Libya should exploit this high clinical trust by introducing mandatory, standardized screening tools—such as the Ages and Stages Questionnaires (ASQ)—directly into routine vaccination schedules. Furthermore, community-based educational campaigns should actively involve fathers and leverage early childhood educators to build a more comprehensive safety net for early detection and therapeutic intervention.

REFERENCES

[1] World Health Organization. (2022). Standards for improving the quality of care for children and young adolescents in health facilities. Geneva: WHO Guidelines.

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions .of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)

[2] Black, M. M., Walker, S. P., Fernald, L. C., et al. (2017). Early childhood development coming of age: science through the life course. The Lancet, 389(10064), 77-90.
[3] Sabanathan, S., Wills, B., & Gladstone, M. (2015). Child development assessment tools in low-income and middle-income countries. Archives of Disease in Childhood, 100(6), 548-554.
[4] Shonkoff, J. P., & Phillips, D. A. (Eds.). (2000). From neurons to neighborhoods: The science of early childhood development. National Academies Press.
[5] Ertem, I. O., Krishnamurthy, V., Mulaudzi, F. M., et al. (2018). Similarities and differences in child development across diverse cultures: Implications for health systems. Pediatrics International, 60(4), 312-321.
[6] Al-Ayadhi, L. Y. (2012). Parental awareness of early developmental milestones and autism indicators in Saudi Arabia. Journal of Pediatric Neurology, 10(2), 99-105.
[7] Zaki, M., El-Sayed, S., & Abdel-Rahman, A. (2020). Knowledge gaps in motor and cognitive milestones among Egyptian mothers. Eastern Mediterranean Health Journal, 26(4), 412-419.
[8] Libyan Ministry of Health. (2024). National Pediatric Healthcare Strategy and Infrastructure Assessment Reports. Tripoli, Libya.
[9] Ben-Gwirah, M., & El-Malti, A. (2021). Maternal health literacy and its relationship with child health outcomes in eastern Libya. Libyan Journal of Medicine, 16(1), 1892104.
[10] Samra, H. A., & McGrath, J. M. (2019). Global perspectives on developmental delay and screen time in early childhood. Journal of Pediatric Nursing, 48, 102-109.
[11] Bornstein, M. H., & Lansford, J. E. (2015). Parenting science and practice in cross-cultural perspective. Child Development Perspectives, 9(4), 220-225.
[12] Rao, N., Sun, J., Wong, J. M., et al. (2014). Early childhood development and education in Sub-Saharan Africa and the Middle East. International Journal of Early Childhood, 46(2), 179-201.
[13] Srinivasan, P., & Al-Khusaibi, S. (2018). Evaluation of developmental delay literacy among parents attending primary health clinics. Oman Medical Journal, 33(3), 211-218.
[14] Hasan, M. M., & Al-Amri, S. (2023). Socioeconomic determinants of parental vigilance regarding neurodevelopmental disorders in North Africa. Arab Journal of Psychiatry, 34(1), 45-56.
[15] Valkenburg, P. M., & Piotrowski, J. T. (2017). Plugged in: How media attract and affect children. Yale University Press.
[16] Frankenburg, W. K., & Dodds, J. B. (1967). The Denver developmental screening test. The Journal of Pediatrics, 71(2), 181-191.
[17] Ozonoff, S., Iosif, A. M., Baguio, F., et al. (2010). A prospective study of the emergence of early behavioral signs of autism. Journal of the American Academy of Child & Adolescent Psychiatry, 49(3), 256-266.
[18] Lord, C., Elsabbagh, M., Baird, G., & Veenstra-VanderWeele, J. (2018). Autism spectrum disorder. The Lancet, 392(10146), 508-520.
[19] Al-Shamsi, M. S. (2021). Primary care screening practices for developmental delays in the Arab world: A systematic review. Journal of Family Medicine and Primary Care, 10(2), 605-612.
[20] Council on Children With Disabilities. (2020). Promoting optimal development: Identifying infants and young children with developmental delays through developmental surveillance and screening. Pediatrics, 145(1), e20193449.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of **LOUJAS** and/or the editor(s). **LOUJAS** and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

(LOUJAS) **Copyright**: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions .of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/)