

Contextualising Health-disaster Risk Reduction Pillars for Under-resourced Rural Secondary Schools in Limpopo Province, South Africa

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Abstract

School communities in under-resourced rural settings face a disproportionate burden of health-related disasters, including outbreaks, water and sanitation failures, food insecurity and compound events that disrupt learning and wellbeing. Yet school based disaster risk reduction (DRR) evidence in Southern Africa is uneven with limited empirically guidance tailored to the organisational and infrastructural realities of disadvantaged schools. Drawing on the Comprehensive School Safety Framework and the World Health Organization's Health Emergency and Disaster Risk Management (Health EDRM) Framework as an analytic lens, this study developed context-specific pillars for health-disaster risk reduction (HDRR) in socio-economically disadvantaged secondary schools in Thulamela Local Municipality, Limpopo Province. A sequential exploratory mixed-methods design was guided the study. In Phase 1, semi-structured interviews, focus group discussions, observations and document review were undertaken with 33 purposively selected stakeholders. Qualitative insights informed a structured questionnaire which was administered in Phase 2 to 308 respondents across three schools and relevant district offices. Thematic network analysis and principal component analysis (varimax rotation) were used for qualitative and quantitative phases, respectively. The results yielded six interrelated pillars which encompassed socio-psychological support and disaster awareness, community-informed planning, emergency health facilities and context-based policies, safe transport and budget allocation, communication and collaboration, and assurance and resource provision. These pillars extend existing school safety guidance by specifying health focused capacities that are feasible within rural schooling systems with limited resources. The paper documented implications for education sector governance, health education coordination and locally accountable resourcing to strengthen preparedness, prevention and adaptation in disadvantaged schools.

Keywords: Child-centred DRR; Health EDRM; Disadvantaged schools; School safety; Disaster governance; Limpopo

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INTRODUCTION

Disaster risk reduction in schools has shifted from a narrow focus on acute hazards to a wider view that includes biological and health risks, chronic stressors and cascading disruptions that disturb educational continuity [1-18]. This shift is evident in the Sendai Framework for Disaster Risk Reduction 2015-2030 which foregrounds risk understanding, governance, investment in resilience and preparedness for effective response. Most importantly, the framework calls for

inclusive approaches that recognise children and young people as rights holders and contributors to risk reduction (UNDRR, [15]2015). Complementing the Sendai Framework, the Comprehensive School Safety Framework (CSSF) articulates three pillars for safer education systems which include safe learning facilities, school disaster management, and risk reduction and resilience education (GADRRRES, [4]2017). In health, the World Health Organisation (WHO) Health EDRM Framework similarly emphasises prevention and mitigation, preparedness, response and recovery as a continuous cycle which is implemented through multi-sectoral collaboration and health-system strengthening (WHO, [18] 2019).

Despite these frameworks, implementation and evidence remain uneven in rural and under-resourced schooling contexts. In South Africa, legislative and policy instruments such as the Disaster Management Act (Act 57 of [6]2002) and successive National Disaster Management Frameworks established principles for integrated risk governance. However, sector-specific translation for schools and the daily challenges of disadvantaged institutions are poorly specified. This gap is detrimental because rural schools are embedded in poverty, infrastructure deficits and limited access to health services (Van Niekerk, [17] 2014). In such areas, health threats quickly become educational threats through psychosocial distress, unsafe water and sanitation conditions [2].

Research on Disaster Risk Reduction (DRR) in and through schools shows the value of disaster education and participatory planning. However, it also highlights policy to practice gaps and uneven capacity in low-resource areas. Studies in South Africa and comparable contexts show that DRR integration into schooling is frequently limited by poor institutional support and inadequate resources (Rambau, [13]2012; Mutasa & Munsaka, [9]2019). In addition, the health dimensions of school risk, particularly psychosocial impacts and the management of outbreaks and chronic service failures are mostly treated as peripheral than core DRR concerns. This is despite evidence that disasters have durable mental health effects and can trigger cascading disruptions (Morganstein & Ursano, [8]2020; Pescaroli & Alexander, [12] 2018).

It is against this background that there is a need for empirically grounded HDRR guidance that is specific enough to be operationalised by schools and district governance structures. Most existing frameworks provide high-level principles, but fewer studies derive context-specific mechanisms from stakeholder experience and then validate them quantitatively to produce a set of implementable pillars. This study responds to that need by developing and validating HDRR pillars in socio-economically disadvantaged secondary schools in Thulamela Local Municipality, Limpopo Province [3].

Under-resourced rural schools in Limpopo Province experience recurrent health-related disruptions. These include infectious disease outbreaks, water and sanitation failures, food insecurity, and mental health stressors but lack an empirically grounded, context-sensitive HDRR framework that is actionable for school management teams. As a result, risk reduction efforts become fragmented, reactive and imported without sufficient localisation. This paper presents a validated set of six HDRR pillars derived from stakeholder experience and confirmed through factor analysis. This paper was aimed at identifying locally feasible pillars for health-disaster risk reduction in socio-economically disadvantaged rural secondary schools in Thulamela Local Municipality [4]. The current paper explored stakeholder experiences of health-related disasters and existing school responses, derived candidate HDRR mechanisms appropriate to under-resourced rural schools and interpret the resulting pillars through an integrated school safety and Health EDRM theoretical lens [5].

THEORETICAL FRAMEWORK

This study used an integrated theoretical framing that brought together the Comprehensive School Safety Framework (CSSF) and the WHO Health Emergency and Disaster Risk Management (Health

EDRM) Framework. These frameworks were interpreted through a socio-ecological view of vulnerability and resilience. The intention was to use these frameworks as conceptual scaffolding for explaining how risk reduction capacities are produced at multiple levels (i.e., individual, school, community, and governance) and across the disaster management cycle [6].

The CSSF specifies that school safety requires attention to safe learning facilities, school disaster management and risk reduction and resilience education. These pillars locate where an HDRR mechanism must be embedded in the school system but they remain broad by design (GADRRRES, [4]2017). Health EDRM complements CSSF by articulating core functions for managing health risks from emergencies and disasters (WHO,[18] 2019).

A socio-ecological framing is especially important in disadvantaged rural schools because vulnerability is produced through interacting social and material processes. These social and material processes include constrained household resources, limited access to health services, inadequate water and sanitation, transport barriers and psychosocial stressors that accumulate over time. This framing treats HDRR capacity as layered from individual level knowledge and coping, school level infrastructure, policies and services, community level networks and support as well as governance level resourcing and accountability. In the analysis and discussion, the empirically derived HDRR pillars are interpreted as configurations of capacities that operationalise CSSF and Health EDRM principles within this socio-ecological reality [7].

METHODOLOGY

Study Design

A sequential exploratory mixed-methods design was employed. The study began with qualitative exploration which was followed by quantitative validation. This design is appropriate where constructs are not well specified in the study context, because it allows locally meaningful items to be generated before statistical reduction and confirmation (Creswell & Plano Clark, [3] 2018). Integration occurred through a building strategy. This means that qualitative results informed the development of the quantitative instrument and results were jointly interpreted during discussion [8].

Study Setting

The study was conducted in Thulamela Local Municipality within Vhembe District of Limpopo Province. The municipality includes predominantly rural settlements and schools that face regular infrastructure and service challenges. The focus was on secondary schools because learners are highly affected by health-related disruptions and are capable of meaningful participation in risk reduction activities [9].

Study Population and Sampling

Participants included learners (Grades 10-12), educators, principals and deputy principals, School Governing Body (SGB) members, circuit education officials and disaster risk reduction officials. In Phase 1, 33 participants were purposively recruited from three socio-economically disadvantaged schools in the Mvudi circuit to capture information-rich perspectives across roles. In the second phase, the sample expanded to 308 respondents across the same schools and relevant district offices. Learners and educators were selected through simple random sampling within participating schools while school leaders, SGB members and officials were recruited purposively to ensure inclusion of decision making roles [10].

Data Collection

The first phase employed semi-structured interviews and focus group discussions to solicit experiences of health-related disasters, perceived vulnerabilities and feasible risk reduction actions. More so, direct observations and document review were used to triangulate accounts and understand

implementation constraints. In the second phase, structured questionnaire (Likert-type items) developed from Phase 1 themes was used. The instrument was reviewed for face validity by subject matter experts and piloted with participants similar to the study population to refine wording and sequencing [11].

Data analysis

Qualitative data were analysed using thematic network analysis where the researcher moved from basic codes to organising themes and global themes (Attride-Stirling,[1] 2001). Coding and theme development were supported by ATLAS.ti (version 9), with memoing used to document analytic decisions and enhance dependability [12].

Quantitative data were analysed in SPSS (version 29). Descriptive statistics were calculated to summarise participant characteristics. Principal component analysis (PCA) with varimax rotation was used to reduce the item set to a smaller number of interpretable components that constitute HDRR pillars. Sampling adequacy was assessed using the Kaiser-Meyer-Olkin (KMO) statistic and Bartlett's test of sphericity. Factors were retained using an eigenvalue greater than one rule, supported by inspection of the scree plot. Items with loadings below 0.50 were excluded from interpretation [13].

Integration and Quality Assurance

Integration followed a building approach where first phase themes shaped the Phase 2 instrument and Phase 2 results were used to refine and prioritise HDRR mechanisms into a coherent pillar structure. Qualitative trustworthiness was enhanced through triangulation across interviews, focus groups, observations and documents as well as through maintaining an audit trail of coding and theme development. Quantitative robustness was supported through factor analytic diagnostics (KMO and Bartlett's test) and transparent factor retention criteria [14].

Ethics

Ethical approval was obtained from the University of Venda Research Ethics Committee. Secondly, the permission to access schools was granted by the District Department of Basic Education. Participants provided informed consent and parental/guardian consent was obtained for learners under 18. Lastly, data were de-identified and stored securely [15].

RESULTS

Results are reported in two stages consistent with the sequential design. First, qualitative findings describe stakeholders' proposed HDRR mechanisms and the logic by which they were grouped. Second, quantitative findings validate and reduce these mechanisms into a smaller set of pillars using PCA [16].

Participant Characteristics

The first phase included 33 participants: learners (n = 12), educators (n = 8), school leaders, SGB members and disaster risk reduction as well as circuit officials. Learners and educators comprised the largest groups, reflecting their central role as both those most exposed to health-related disruptions and those who routinely implement school-level responses [17].

The second phase included 308 respondents drawn from three schools and district structures. Most respondents were learners (67.9%), followed by school staff (23.1%) and SGB members (5.5%), officials from the disaster risk reduction office and circuit education office accounted for 2.6% and 1.0%, respectively. The sample was predominantly female (58.1%).

Qualitative HDRR Mechanisms

Qualitative analysis generated three organising domains for HDRR mechanisms, which included disaster preparation, disaster prevention and disaster adaptation. These domains reflect stakeholders'

emphasis on the full risk management cycle, spanning anticipatory capacity building, measures to reduce impacts before crises escalate, and the ability to adjust practices and policies as risks evolve. Figure 1 summarises the mechanisms identified across these domains. (Figure-1)



Disaster Preparation

Participants emphasised readiness and operational preparedness. Proposed actions included regular drills and simulations, development of context-based school emergency operation plans, strengthening in-school emergency health response capacity and improving infrastructure (including classrooms and reliable access to safe water). Respondents also highlighted the importance of partnership based resourcing, clear communication protocols, dedicated budgeting and safe transport arrangements for referral to health facilities when cases exceed school capacity. Illustrative participant statements included:

“There is a need for funding from the government to adequately prepare for disasters.”

Educator

“The government together with private sectors need to assist with building enough classrooms and also consistent provision of clean running water.”

SGB member

“By partnering with local government and the community, schools can craft a robust school emergency operation plan.”

Disaster risk reduction officer

“There should always be transport to accompany learners to the hospital if the situation is above the school.”

Learner

Disaster Prevention

Prevention-focused mechanisms aimed to reduce the likelihood and severity of health related impacts. Participants prioritised post incident review processes, strengthening psychosocial support and ensuring the availability of qualified personnel during school hours for acute events. They also suggested integrating disaster awareness into academic programmes, reinforcing communication routines and ensuring consistent provision of hygiene related supplies. Selected statements from participants included:

“We need to engage school administrators, educators, learners and parents to participate in ongoing school community disaster prevention activities.”

Staff member

“The schools should be given qualified people who will always be available throughout the school hours; for example, if a child faints, there should always be a person monitoring the child.”

Learner

“Resources required during health disasters such as water, sanitary equipment and others should be adequately provided.”

Circuit officer

Disaster Adaptation

Adaptation mechanisms were framed as the ability to adjust school practices and governance arrangements as conditions change. Participants believed that adaptation in schools should encompass hygiene promotion, local health and safety policies, school-based emergency facilities and regular post-disaster assessment to learn from events and update procedures. Community engagement was again emphasised, both as a mechanism for understanding evolving vulnerabilities and as a pathway for mobilising support. Illustrative statements included:

“There is a need to do a thorough post-disaster assessment. This helps schools to make changes to a few things that might have made the previous health disasters worse.”

SGB member

“Local schools should adapt by formulating new policies which will ensure effective teaching and learning during and after disasters.”

Staff member

“There should be a school therapist available to help children traumatised by the event.”

Learner

Quantitative Validation: HDRR Pillars (PCA)

PCA was used to validate and reduce the set of candidate mechanisms. Sampling adequacy was acceptable (KMO = 0.734). Bartlett’s test of sphericity was significant (chi-square = 575.286, df = 91, $p < 0.001$), indicating sufficient inter-item correlation for factor extraction. Six components with eigenvalues greater than 1 were retained, accounting for 63.576% of the total variance (Table 1).

Table 1. Sampling adequacy test of the PCA

KMO and Bartlett’s Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.734
Bartlett’s Test of Sphericity	Approx. chi-square	575.286
	df / Sig.	91 / < 0.001

Table 2. Health-disaster risk reduction pillars in schools based on principal component analysis with varimax rotation (N = 308)

Items	Factor 1: Socio- psychologi- cal support & disaster awareness	Factor 2: Communi- ty- informed planning	Factor 3: Emergency health facilities & context- based policies	Factor 4: Safe transport & budget allocation	Factor 5: Communi- cation & collaborat- ion	Factor 6: Assuranc- e and resource provision	Comm- unities
8.5 Establishment of functional in-school socio-psychological support services	0.820						0.702
8.6 Invest in climate adaptation and disaster awareness	0.808						0.672
6.1 Community engagement in health disaster preparedness		0.707					0.635
7.1 Disaster prevention community engagement		0.691					0.716
6.2 Comprehensive context-based disaster preparation plans		0.673					0.647
7.3 Establishment of school-based emergency health facilities			0.676				0.572
7.4 Implementation of local health and safety policies in schools			0.634				0.475
6.9 Provide an effective emergency transport system				0.732			0.654
6.6 Improved government disaster budget				0.609			0.490

6.4 Effective communication protocols					0.783		0.669
6.8 Establish partnerships with public and private institutions					0.763		0.668
8.4 Effective communication and assurance						0.833	0.781
7.6 Provision and enhancement of disaster risk reduction resources						0.660	0.672
Eigen values	3,121	1,337	1,247	1,139	1,056	1,000	(Total V)
% Variance	22,296	9,552	8,910	8,133	7,540	7,146	63,576

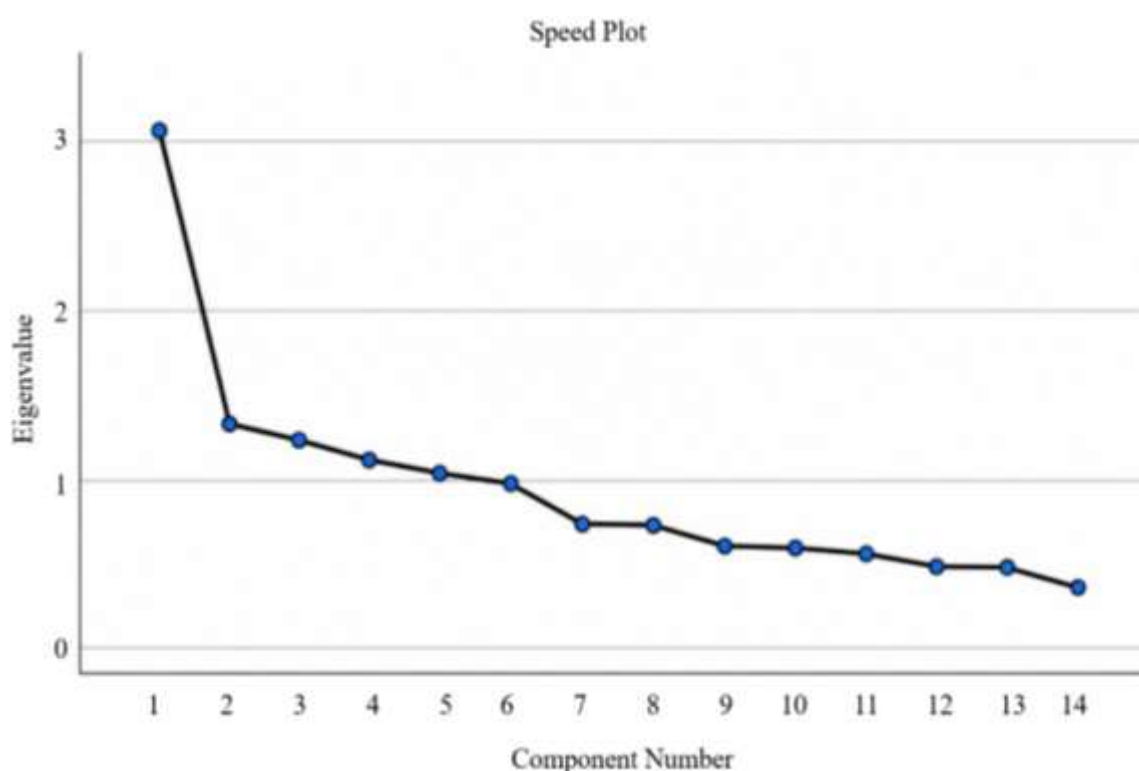


Figure 2. Scree plot showing extracted components from principal component analysis.

The extracted components were interpreted as six HDRR pillars for rural schools. The first factor explained 22.296% variance and captured socio-psychological support and disaster awareness. The second factor (9.552%) reflected community-informed planning. The third factor (8.910%) was on emergency health facilities and context based policies. Factor 4 (8.133%) represented safe transport and budget allocation. Factor 5 (7.540%) captured communication and collaboration. The last factor which explained 7.146% variance was labelled assurance and resource provision. (Figure 2) (Table 2)

DISCUSSION

This study produced a context specific and empirically supported model of health disaster risk reduction (HDRR) for disadvantaged rural secondary schools. The combined qualitative and quantitative findings suggested that HDRR in such settings is not reducible to emergency drills or awareness campaigns alone. Rather, it depends on a layered set of psychosocial, institutional, infrastructural and relational capacities that work together under conditions of scarcity. This interpretation is well aligned with both the Comprehensive School Safety Framework (CSSF), which treats school safety as a combination of safe facilities, school disaster management, risk reduction and

resilience education. It is also aligned to the WHO Health Emergency and Disaster Risk Management (Health EDRM) framework which emphasises prevention, preparedness, response and recovery as interconnected functions not as isolated actions (GADRRRES, [4]2017; UNDRR, [16] 2019; WHO,[18] 2019). In this sense, the present findings extend existing guidance by showing how these broad international principles take shape in under resourced rural schools where hazards intersect with poor infrastructure, limited service access and everyday social vulnerability [18].

The prominence of socio-psychological support and disaster awareness as the strongest pillar is consistent with a substantial body of disaster literature showing that the effects of disasters on children and adolescents are physical, emotional, behavioural and educational. Studies show that exposure to disasters can disrupt concentration, attendance, social functioning and general well-being, with consequences that often go beyond the immediate event (Morganstein & Ursano, [8] 2020; Peek et al., [11]2018). The qualitative findings in this study suggested that participants did not see awareness as only the communication of hazard information. Rather they linked awareness to emotional readiness, coping and the ability to respond appropriately under stress. This is an important distinction as it suggests that in rural school settings, resilience education must include psychosocial preparedness if it is to be helpful. The result therefore supports the CSSF view that school safety should include knowledge building and protective support systems while reinforcing the Health EDRM position that preparedness and recovery are inseparable from mental and social well being (GADRRRES, [4]2017; WHO, [18] 2019).

The pillar on community informed planning also resonates strongly with the Sendai Framework which places considerable emphasis on inclusive, multi-stakeholder disaster risk governance, arguing that local knowledge and shared responsibility are central to effective risk reduction (UNDRR, [15] 2015). The present findings support that position at school level. Participants consistently described HDRR as more credible and workable when parents, local leaders, clinics and other community actors were involved in planning and implementation. This is in line with evidence from school DRR studies showing that preparedness becomes more sustainable when schools are not treated as part of a broader social and institutional ecosystem (Mutasa & Munsaka,[9] 2019; Sakurai *et al.*,[14] 2018). In the context of the current study, community-informed planning appeared to function as a practical strategy for addressing the realities of rural deprivation. Through the socio-ecological lens used in this paper, this pillar reflected the importance of linkages across household, school, community and governance levels.

The findings on emergency health facilities and context-based policies pointed to an issue that is often underdeveloped in school DRR research which is the gap between policy intent and operational capacity. Respondents highlighted the need for local emergency health arrangements, basic response resources and policies that are adapted to the realities of poor transport, delayed referrals and fragile service systems. This is in line with the CSSF pillar on safe learning facilities and with the preparedness and response components of Health EDRM which stress that institutional readiness must be grounded in risk conditions (GADRRRES, [4]2017; WHO,[18] 2019). This also speaks to critiques of disaster governance in South Africa, where legislation and frameworks are robust in design but uneven in implementation in settings with inequality and poor local capacity (Van Niekerk, [17]2014; Government of South Africa, [7]2023). What emerged from this study was that school-based HDRR cannot rely on generic policy compliance alone. It requires context-sensitive policy routines that anticipate the types of failures most likely to arise in rural schools.

Safe transport and budget allocation emerged as another important pillar. While international school safety frameworks acknowledge the importance of facilities, management systems and coordination the practical role of transport and ring-fenced resourcing is not sufficiently foregrounded in school level discussions. In the present study, participants viewed these factors as decisive for whether response systems could function in practice. This is a critical insight because it shows that

preparedness is a matter of logistical reach and material continuity. In rural contexts, where referral systems depend on long travel distances and where schools normally operate under severe budgetary challenges, transport and funding are core components of risk reduction rather than secondary administrative concerns. This interpretation is in line with systems oriented thinking in disaster studies, which shows that risks often cascade through infrastructural and organisational weaknesses than through a single hazard event alone (Pescaroli & Alexander,[12] 2018). The result therefore strengthens the argument that HDRR in disadvantaged schools must be understood as a problem of systemic vulnerability.

Past studies have shown that school preparedness is stronger where roles are clear, communication channels are established and partnerships are maintained across sectors before a disaster occurs (Sakurai *et al.*, [14]2018; Rambau *et al.*, [13]2012). The present results showed that pattern. Participants described the need for dependable contacts, information flow, interdepartmental coordination and collaboration between education, health and disaster management structures. This closely reflects both Sendai's governance orientation and the Health EDRM emphasis on coordination across sectors and levels of action (UNDRR, [15] 2015; WHO, [18]

2019). It also suggests that collaboration is not merely beneficial but foundational in disadvantaged contexts, where no single institution is likely to hold all the resources required to manage risk effectively.

The final pillar, assurance and resource provision, adds an important social dimension to the model. Participants linked effective HDRR to visible support, timely information, and the consistent availability of basic protective resources. This finding suggests that trust, institutional credibility, and material support are closely connected. When schools are visibly supported, prevention measures are more likely to be taken seriously and recovery efforts are more likely to be sustained. Although this theme is sometimes implicit in disaster frameworks, the current findings make it more explicit by showing that assurance functions as a form of social stabilisation in uncertain environments. In that respect, the result aligns with broader resilience thinking, which recognises that people's willingness to engage with protective systems depends partly on whether those systems appear reliable, responsive, and fair (WHO,[18] 2019; Peek *et al.*, [11]2018).

The six pillars showed that HDRR in rural secondary schools is best conceptualised as a multi-level capability system. The results support the theoretical position adopted in this paper, namely that school disaster risk reduction and school health resilience are shaped by the interaction of institutional structures, social relationships, local context and material resources. The findings also help to explain why interventions sometimes underperform in vulnerable school settings. Programmes that emphasise awareness alone without attending to psychosocial support, local policy fit, transport feasibility, communication routines and minimum resource assurance are unlikely to generate durable resilience. This insight is consistent with literature showing that sustainable school preparedness depends on a minimum set of interdependent essentials than isolated activities (Sakurai *et al.*, [14]2018; GADRRRES, [4]2017). The present study therefore contributes to the literature by translating broad HDRR principles into a grounded and testable framework that better reflects the realities of disadvantaged rural schools.

Implications for Policy and Practice

At school level, it is critical to establish minimum emergency response and communication routines, build psychosocial support and referral pathways as well as deepen community informed planning and context-based policy routines. At district and municipal levels, the findings imply that HDRR should be treated as a joint education health governance issue, with explicit accountability for safe transport arrangements, minimum WASH continuity and predictable resourcing. The National

Disaster Management Centre's DRR School Toolkit initiative provides an entry point for integrating these pillars into education sector planning.

Limitations and Future Research

The study was conducted in three schools within one municipality and the pillar structure may reflect local risk profiles and institutional arrangements. However, this set a blueprint and a basis for future research to test the pillar model in other rural districts, examine how pillars predict observed preparedness and response outcomes and assess implementation fidelity and cost implications. Longitudinal work is also needed to understand how pillar priorities shift as hazards and vulnerabilities evolve.

CONCLUSION

This study developed and validated six pillars for health-disaster risk reduction in socio-economically disadvantaged rural secondary schools in Thulamela Local Municipality. The pillars emphasise that effective HRRR requires more than awareness-raising. It depends on psychosocial support, community-informed planning, context-based policies and onsite capabilities, feasible transport, resourcing and robust communication as well as collaboration routines that build trust. By mapping the empirically derived pillars to CSSF and Health EDM principles, the paper provides a transferable, theory-informed framework that can guide school planning and district-level investment to strengthen preparedness, prevention, and adaptation in under-resourced schooling systems.

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