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Smart Diet Diary: Design and Development of a Mobile Application for Child Nutrition Guidance in Tanzania

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ABSTRACT

Child undernutrition remains a major public health challenge in Tanzania, with stunting affecting approximately 34% of children under five. Limited access to nutrition professionals, geographic barriers to health services, and inconsistent caregiver knowledge constrain access to age-appropriate dietary guidance. This study developed Smart Diet Diary, a mobile application designed to support nutrition guidance for children under six by enabling registered nutritionists to publish age- and weight-based dietary plans accessible to parents and caregivers. A Design Science Research approach was adopted, with requirements gathered through semi-structured interviews with five nutritionists from four hospitals in Dar es Salaam and informed by a narrative review of World Health Organization infant and young child feeding guidelines. The application was developed using Flutter/Dart, PHP, MySQL, and a REST API. Validation included functional testing of all core requirements and a User Acceptance Test involving 20 participants, yielding mean usability and acceptability scores ranging from 4.4 to 4.7 out of 5. The findings demonstrate the technical feasibility and preliminary user acceptability of the application as a nutrition decision-support tool. However, no clinical or behavioural outcomes were assessed; further large-scale usability and impact studies are required before broader deployment.

Keywords: Child undernutrition; mobile health (mHealth); nutrition decision support; caregiver guidance; usability evaluation; Tanzania

INTRODUCTION

Globally, about one in four children under five years of age is stunted, with the majority of affected children living in sub-Saharan Africa and South Asia (WHO, UNICEF and World Bank, 2022). Stunting, defined as low height-for-age, is a long-term consequence of chronic undernutrition and has been associated with impaired cognitive development, reduced educational attainment, lower adult earnings, and greater susceptibility to infection and chronic disease (Black et al., 2013). The first 1,000 days of life, from conception to the second birthday, are widely recognised as a critical window in which adequate nutrition supports healthy growth trajectories. Tanzania, also continues to carry a substantial burden of child undernutrition. The 2022 Tanzania Demographic and Health Survey reports a stunting prevalence of approximately 34% among children under five (Ministry of Health and National Bureau of Statistics, 2022), placing the country among the higher-burden settings in sub-Saharan Africa. The drivers of this burden are widely understood

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to be multi-causal and structural, encompassing household poverty, food insecurity, limited dietary diversity, sub-optimal infant and young child feeding (IYCF) practices, recurrent infection, restricted access to health services, and uneven caregiver knowledge of age-appropriate feeding (Bhutta et al., 2020; Ndagijimana et al., 2022; Dabar et al., 2020). Cultural practices and beliefs about child feeding further shape outcomes, particularly in peri-urban and rural communities where contact with formal health services is intermittent. Any single intervention can therefore address only a subset of these drivers, and digital tools in particular are best understood as one supportive component within a broader, multi-sectoral response.

Within this multi-causal picture, caregiver knowledge of age-appropriate feeding remains a modifiable factor with practical relevance. Traditional mechanisms for delivering dietary guidance in-person counselling, community health worker visits, and printed materials are constrained by the limited number of nutrition professionals relative to the population and by distance from formal health facilities (URT, 2021; Bhutta et al., 2020). National workforce data for Tanzania indicates that the number of trained nutritionists per population is substantially lower than the densities recommended for adequate nutrition counselling capacity in low- and middle-income settings (URT, 2021). This points to a gap in routine access to professional dietary advice that complementary, lower-cost channels may help to fill. Mobile phones offer one such complementary channel. National data from the Tanzania Communications Regulatory Authority indicate mobile phone subscription penetration above 90% by late 2025 (TCRA, 2025), although it is important to distinguish total subscriptions from smartphone ownership: smartphone penetration is meaningfully lower than the headline mobile figure, with reported smartphone uptake in Tanzania still well below universal coverage and more limited in lower-income and rural households (GSMA, 2023). A mobile-application channel is therefore most likely to reach urban and peri-urban caregivers in the short term, with broader reach contingent on continued growth in affordable smartphone access. Mobile health (mHealth) interventions have been studied across a range of conditions in low- and middle-income countries, with reviews reporting mixed but generally positive effects on information delivery, behaviour-relevant outcomes and service uptake (Labrique et al., 2013; Aranda-Jan et al., 2014; Free et al., 2013), while nutrition-focused mHealth tools designed for early childhood dietary guidance in East Africa remain comparatively few.

This paper describes the design and development of the Smart Diet Diary, a mobile application intended to support caregivers of children under six years of age in Tanzania by providing access to age- and weight-indexed dietary plans authored by registered nutritionists. The contribution of the study is methodological and engineering in nature: it documents the requirements gathered with hospital-based nutritionists, the system design and architecture, the implementation in a Flutter/PHP/MySQL stack, and software-level validation of the resulting prototype. The study does not measure changes in feeding practices, dietary intake, or anthropometric outcomes; such clinical and behavioural evaluations are identified as essential follow-on work. The specific objectives of this work were to: (i) gather requirements for a paediatric dietary guidance application from hospital-based nutritionists in Dar es Salaam, with caregiver perspectives drawn from existing literature;

(ii) design the system using OOAD principles and UML notation; (iii) implement the application using the Flutter/Dart, PHP and MySQL stack with a REST API; and (iv) validate the prototype at the software level through functional testing and a small User Acceptance Test.

LITERATURE REVIEW

Child Undernutrition and IYCF Practices

Child undernutrition includes stunting, wasting, underweight, and micronutrient deficiencies, with stunting being the most prevalent form in sub-Saharan Africa (WHO, UNICEF and World Bank, 2022). Beyond mortality risk, stunting in early life has been associated with reduced cognitive performance, lower school attainment, and lower adult productivity, contributing to intergenerational disadvantage (Dewey and Begum, 2011; Black et al., 2013). Recommended IYCF practices exclusive breastfeeding for the first six months, timely introduction of nutritionally adequate complementary foods, and continued breastfeeding through the second year remain among the most cost-effective interventions for preventing stunting and reducing child mortality (Bhutta et al., 2020). Despite this evidence, adherence to recommended IYCF practices is uneven, with inadequate dietary diversity and sub-optimal complementary feeding consistently reported as proximate drivers of undernutrition in the region.

mHealth in Maternal and Child Nutrition

A substantial body of mHealth research has explored the use of mobile phones to support maternal and child health services in low- and middle-income countries, including appointment reminders, health information delivery, and behaviour change communication (Free et al., 2013; Lund et al., 2012; Labrique et al., 2013). In the nutrition domain, Darawati et al. (2020) reported short-term improvements in dietary intake among Indonesian children under five following a smartphone-supported counselling intervention, and Billah et al. (2017) used a smartphone-assisted intervention package within a cluster randomised trial of nutrient supplementation in Bangladesh. Read critically, however, these studies share methodological weaknesses that constrain how their evidence can be generalised: short follow-up periods (often under six months), heterogeneous outcome definitions, and a reliance on study staff to operate the digital component rather than on caregivers self-servicing the tool. Evidence on sustained behavioural change is therefore thinner than aggregate review-level claims sometimes suggest (Aranda-Jan et al., 2014; Marcolino et al., 2018). They also illustrate two recurring patterns in the wider literature: mHealth tools have been used most often as adjuncts within structured research trials, and outcomes have been mainly measured at the level of intake, behaviour, or service contact rather than at the level of population stunting. A further recurring limitation is that most reported tools were designed for trial conditions rather than for routine, self-service caregiver use, and few publications report on usability, accessibility, or deployment readiness for non-trial caregiver populations (Sondaal et al., 2016; Marcolino et al., 2018).

In the African region, Nsereko et al. (2018) examined feeding practices and stunting determinants among Rwandan children using digital data collection methods, identifying early cessation of exclusive breastfeeding and low dietary diversity as key modifiable factors. Ndagijimana et al. (2022) found that food insecurity was a leading correlate of malnutrition in their analysis of Rwandan data and emphasised that interventions which only address caregiver knowledge will be insufficient without parallel attention to food

access. The evidence from these studies is consistent in directionality but uneven in methodological rigour: sample frames are often hospital- or facility-based and therefore biased toward care-seeking households, instrument validity for dietary recall in low-literacy populations is rarely reported, and few studies follow children long enough to link the identified determinants to growth trajectories. Comparable Tanzanian primary studies are scarce, and the evidence base for digital interventions in Tanzania remains weaker than for service-level mHealth tools (Sabben et al., 2021). These studies therefore usefully contextualise the present work but also reinforce a critical observation: dietary information tools cannot, on their own, resolve nutritional outcomes shaped by household food access, sanitation, infection, and maternal education.

Digital Diet Management Tools and the Tanzanian Context

Consumer-facing dietary tracking applications such as MyFitnessPal and Cronometer are designed primarily for adult users in high-income settings, rely on Western food databases, and assume both high digital literacy and self-directed calorie management (Lieffers and Hanning, 2012); these design choices limit their relevance to caregivers of young children in sub-Saharan Africa. Pediatric-focused nutrition applications for low-resource settings remain comparatively few, and where they exist they have typically been embedded within research trials rather than released as openly available tools. Studies that have evaluated such tools have often used investigator-developed satisfaction questionnaires rather than standardised usability instruments such as the System Usability Scale (Brooke, 1996) or the Technology Acceptance Model (Davis, 1989), making cross-study comparison difficult and limiting the cumulative evidence on what design choices generalise across contexts (Maramba et al., 2019). In Tanzania specifically, digital health activity has grown around maternal and child health programmes including the Wazazi Nipendeni ("Parents Love Me") Short Message Service, mobile-based community health worker registers, and the Afya-Tek pilot integrating community health worker and facility data, demonstrating both feasibility and uptake of mobile-based health information services in the country (Sabben et al., 2021; D-tree International, 2022). However, these initiatives are predominantly Short-Message-Service-driven or focused on service delivery and supervision rather than on age- and weight-indexed dietary content for caregivers. The published evaluations of these programmes also remain heavier on reach and uptake than on behavioural or nutritional outcomes, leaving an evidence gap around what content depth and interaction modality are needed to support caregiver dietary decisions specifically (Sondaal et al., 2016). The available evidence therefore points to a specific design gap: a smartphone-based application in which nutrition content is curated by registered nutritionists and retrievable by caregivers using simple child-level parameters has not been widely documented for the Tanzanian context.

Identified Gap and Positioning of the Present Work

Across the reviewed literature, three recurring limitations are apparent. First, most validated nutrition mHealth tools have been built for research-trial use and are not readily deployable as routine caregiver-facing applications. Second, consumer dietary applications that are deployable are not designed for caregivers of young children or for African food and language contexts. Third, available digital health activity in Tanzania has prioritised Short-Message-Service-based information and service-

delivery tools rather than nutritionist-governed dietary applications for parents. The contribution of the present work is therefore framed cautiously and at the level of design configuration rather than at the level of a novel scientific intervention. The Smart Diet Diary combines three features that, to the best of the authors' knowledge, have not previously been assembled within a single deployable Tanzanian tool: (i) dietary content authored and governed exclusively by registered nutritionists rather than user-generated or crowdsourced; (ii) retrieval keyed to caregiver-entered child age and weight rather than to caregiver self-reported food intake; and (iii) a locally referenced feeding knowledge base aligned to World Health Organization infant and young child feeding guidance. The prototype is not presented as a clinically validated intervention but as a software artefact intended as a foundation for subsequent usability and clinical evaluation. The novelty claim is configurational and is acknowledged to require empirical confirmation in later work.

METHODOLOGY

Research Strategy and Methodological Layering

The study followed a Design Science Research (DSR) strategy at the level of overall research paradigm; DSR is concerned with the design and evaluation of information technology artefacts as a means of addressing practical problems (Hevner et al., 2004). Within this paradigm, distinct methodological layers were used for different phases of the work and are reported separately to avoid conflating them. Object-Oriented Analysis and Design (OOAD) was used as the analysis and design method for system specification; the Unified Modelling Language (UML) was used as the diagrammatic notation in which design artefacts were expressed; and an Agile, iterative workflow was used for software construction. In summary: DSR is the research paradigm, OOAD/UML is the analysis-and-modelling layer, and Agile is the implementation workflow.

Requirements Gathering

Primary data were collected through semi-structured interviews with hospital-based nutritionists working in paediatric nutrition and growth-monitoring services at four hospitals in Dar es Salaam: Muhimbili National Hospital, Kairuki Hospital, Mwananyamala Regional Hospital, and Aga Khan Hospital. Purposive sampling was used to identify nutrition professionals with day-to-day experience advising parents of children under six. Five nutritionists participated in interviews of approximately 30–45 minutes each. The interview protocol covered: (i) essential food categories for children under six; (ii) dietary adjustments for frequently ill children; (iii) meal schedules by developmental stage; (iv) common questions raised by parents; and (v) strategies for adjusting children's diets as nutritional needs evolve. Interview notes were thematically coded to derive a User Requirements Specification, which informed both the use case design and the dataset structure. The choice of five participants is justified on three methodological grounds. First, the interviews were conducted to elicit professional expert input for prototype scoping rather than to generate population-representative estimates; in this expert-elicitation mode, the principle of information power (Malterud, Siersma and Guassora, 2016) supports relatively small samples when participants hold highly specific knowledge and the analytical aim is narrow. Second, after the fifth interview the research team observed substantial conceptual repetition across responses on the five protocol items, indicating that additional interviews with

comparably positioned professionals in the same urban network were unlikely to materially alter the requirement set at this design stage. Third, the prototype scope was limited to what the rule-based age- and weight-indexed retrieval mechanism can usefully express, constraining the additional design value of further requirements input until that scope is expanded. These three considerations do not establish statistical representativeness, and the study does not claim such representativeness; broader and rurally inclusive elicitation is identified as a priority follow-on activity. Primary interviews with caregivers were not conducted in this iteration. Because caregivers are the application's primary intended users, the rationale for the scope of the requirements phase is set out explicitly below.

Three considerations shaped the scope of the requirements phase. First, this iteration is positioned at the design science prototype stage, in which the analytical goal is to establish whether a nutritionist-governed retrieval architecture can be specified and built in this setting rather than to validate caregiver-facing interaction at scale; caregiver primary data are scheduled for the participatory redesign phase that follows the prototype. Second, the content authored within the system is professional dietary guidance and must originate from registered nutritionists; caregiver input is therefore most useful for interaction, language, and accessibility decisions that follow once the underlying content model is in place. Third, primary caregiver research in this domain in Tanzania requires formal ethical clearance through the National Institute for Medical Research and a Data Protection Impact Assessment under the Personal Data Protection Act (2022), and is appropriately conducted as part of the next phase rather than alongside prototype construction. Caregiver-side requirements were therefore derived indirectly from two sources: a narrative review of published qualitative and quantitative studies of caregiver feeding practices and information needs in East Africa (e.g., Nsereko et al., 2018; Ndagijimana et al., 2022), and structured reflections from the participating nutritionists on the questions caregivers most commonly raise in clinic. The narrative review followed pre-specified inclusion criteria (English-language, sub-Saharan African setting, paediatric nutrition or mHealth focus, 2010 onwards) but did not use a registered protocol, double-screening, or formal quality appraisal; it is therefore reported as a narrative review and not as a systematic review. Direct caregiver interviews and a small participatory design phase are identified as priority follow-on activities.

System Design

Design Approach

System analysis and design used OOAD methodology with UML notation. OOAD was selected for its emphasis on modular decomposition, encapsulation, and behavioural modelling properties that support iterative implementation and future extensibility. Three core artefacts were produced: a use case diagram describing actors system interactions for the parent/caregiver, nutritionist, and administrator roles; a class diagram describing system entities and their relationships; and a system architecture diagram describing the client–server communication model.

System Overview and Use Cases

The Smart Diet Diary supports two end-user classes parents and caregivers, and registered nutritionists with an additional administrator role responsible for overall account and content governance. The use case design captures six core interactions: user

registration, authentication (login), application management by the administrator, dietary plan posting and editing by nutritionists, plan search and retrieval by parents/caregivers, and logout. Role-based access control ensures that only nutritionist accounts can author or modify dietary content; parent/caregiver accounts have read-only access to that content.

Data Model and Scope of Personalisation

The current data model is deliberately compact and comprises three principal entities. The USERS entity stores account-level information (user identifier, name, phone number, email address, password hash). The ROLE entity associates each account with a role (nutritionist, parent/caregiver, or administrator). The DIET entity stores the dietary plan record (plan identifier, applicable age range, applicable weight range, plan name, description, image, and authoring nutritionist). The USERS–DIET relationship is one-to-many on the nutritionist side. Plan retrieval in the Smart Diet Diary is a deterministic rule-based lookup on two parameters the child's age and weight against nutritionist-authored plan ranges. It is not an adaptive recommendation engine, it does not learn from user behaviour, and it does not perform individualised inference in the machine-learning sense. The retrieval is described throughout this paper as "age- and weight-matched" or "rule-based age–weight filtering" to reflect this scope. A richer model that would accommodate longitudinal feeding history, anthropometric trajectories, allergies, household food availability, and recurrent illness was out of scope for the prototype and is identified as future work. The age range is encoded as a decimal pair (for example 0–0.9, 1–1.9), in which the integer part represents completed years and the decimal part represents months as tenths of a year. This encoding was chosen to keep storage simple at the prototype stage; a more clinically conventional months-based representation is recommended for the next iteration.

Application Architecture

The system uses a three-tier client–server architecture: (i) a Flutter-based mobile client; (ii) a server-side application layer implemented in PHP exposing a REST API; and (iii) a MySQL relational database. Client–server communication uses HTTP-based REST calls with GET, POST, PUT and DELETE methods. Figure 1 shows the overall architecture.

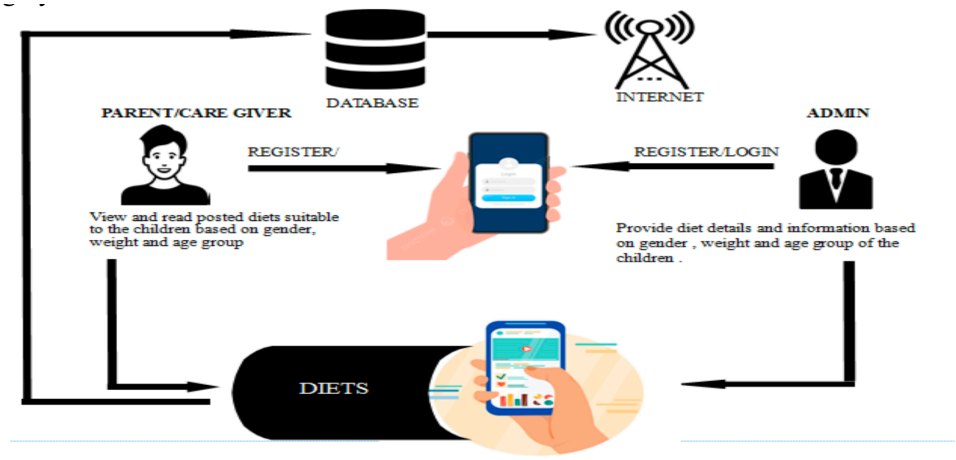

Figure 1: System Architecture of the Smart Diet Diary Application

The presentation layer renders a Flutter-based interface with a consistent green-themed colour scheme. The application layer hosts authentication, request validation, business rules, and database access logic. The data layer stores user accounts, role assignments, and dietary content. This separation allows independent evolution of each layer; for example, the application layer could later be extended with a recommender service or a web-based administrative portal without changes to client-side code.

Ethical, Privacy and Security Considerations

The prototype was developed at Ardhi University as an engineering and design exercise, and the data collected during the requirements phase were limited to professional opinions from consenting nutritionists about their general clinical practice; no patient-identifiable data, child anthropometric data, or facility-held records were accessed at this stage. All five participating nutritionists provided informed verbal consent prior to interview, were informed that participation was voluntary, and were given the option to review the use to which their input would be put.

Any future deployment that collects child-level data including age, weight, feeding history, or images of named children must be preceded by formal ethical clearance from the National Institute for Medical Research (NIMR) and from the relevant university research ethics committee, written caregiver consent, and a Data Protection Impact Assessment under Tanzania's Personal Data Protection Act (2022). The current prototype follows a data-minimisation principle: only the parameters required for plan matching are accepted as user input, and no persistent child-level health record is maintained on the server.

On the security side, the current implementation supports password-based authentication with hashed password storage using a salted one-way hash and a one-time passcode (OTP) step during account registration and recovery. This baseline is appropriate for a research prototype but does not meet the security and data-governance posture expected of a production child-health application. The following controls are not yet in place and are prerequisites for any move beyond the prototype stage: (i) Transport Layer Security (TLS 1.2 or higher) for all client–server traffic, with certificate pinning on the mobile client; (ii) encryption at rest for the database and for any uploaded images, with key management held outside the application server; (iii) formal penetration testing covering the Open Web Application Security Project (OWASP) Mobile Top 10 and Application Programming Interface (API) Top 10 categories; (iv) an access-control audit with role-based access enforced at the server, not only at the client; (v) secure session lifecycle management including token expiry, refresh-token rotation, and forced sign-out on credential change; (vi) rate-limiting and brute-force protection on authentication endpoints; (vii) structured server-side logging that excludes personally identifying fields; and (viii) a documented incident-response and breach-notification procedure. On the data-governance side, a deployment-ready version of the Smart Diet Diary would be regulated as a processor of personal data, and in some configurations as a processor of children's data, under the Personal Data Protection Act (2022). A Data Protection Impact Assessment, registration of the data controller, written caregiver consent that explicitly addresses child-data processing, a documented data-minimisation policy, a documented retention and deletion schedule, and a parental access-and-erasure mechanism are required before any caregiver-facing deployment. Ethical

clearance from the National Institute for Medical Research and from the relevant university research ethics committee is a parallel requirement. These items are listed in the future-work agenda and in the recommendations and remain outstanding for any caregiver-facing deployment.

Implementation

Implementation followed an Agile, iterative workflow. Functional modules were planned in short sprints, with each sprint producing a build that was reviewed against the User Requirements Specification before the next sprint began. The development stack comprised the Flutter framework (version 3.x) with the Dart language for the mobile client, Visual Studio Code as IDE, PHP for backend services, MySQL administered via XAMPP during local development, and StarUML and Draw.io for design diagrams. Flutter was selected for its single-codebase Android/iOS coverage (Flutter Team, 2024).

Software Validation

Two software-validation activities were carried out: functional testing and a small User Acceptance Test. Both are software-level checks and do not constitute clinical or behavioural evaluation. Functional testing assessed whether each functional requirement performed correctly under expected conditions. Test cases were derived from the use case diagram and the User Requirements Specification, and outcomes were recorded in a structured functional testing matrix. A “pass” in this matrix indicates that the corresponding requirement behaved as specified under controlled inputs; it does not indicate that the underlying clinical advice is effective in changing feeding behaviour or growth outcomes.

User Acceptance Testing was conducted as a small software-acceptability study. Twenty participants (15 parents/caregivers and 5 nutritionists) were recruited by convenience from the same Dar es Salaam hospital network that supported the requirements phase. The recruitment rationale was pragmatic: caregivers attending growth-monitoring visits and nutritionists from the participating hospitals could complete the protocol within a single clinic visit, and recruitment in this network did not require a separate clinical ethics approval beyond the institutional permission already granted for the prototype development exercise. This recruitment strategy yields an urban, care-seeking, convenience sample and accordingly limits external validity; replication with rurally drawn, lower-literacy, and lower-connectivity caregivers is identified as a required next step. Participants worked through five task scenarios (registration, login, diet posting by nutritionists, dietary plan search by parents, and logout) and then completed a five-item Likert-scale questionnaire (1 = strongly disagree to 5 = strongly agree) covering ease of use, content accuracy, interface clarity, perceived usefulness, and overall satisfaction. The instrument was investigator-developed rather than a published standardised tool such as the System Usability Scale (Brooke, 1996) or a Technology Acceptance Model questionnaire (Davis, 1989); item wording was face-validated with two of the participating nutritionists before administration, but no formal psychometric validation, factor analysis, or test–retest reliability assessment was performed. Scoring was interpreted at the level of mean Likert score and the share of responses in the 4–5 agreement band per item; no composite usability index, percentile ranking, or threshold-based pass/fail judgement was applied, and no inferential statistical testing was performed because the sample is too small to support it. Task-completion times, error rates, qualitative cognitive-walkthrough data, and a comparator interface were not captured.

Given these instrument, sampling, and analysis limitations, the User Acceptance Test results are best interpreted as preliminary acceptability indicators rather than as a validated usability assessment. A larger, instrumented usability study using the System Usability Scale, task-completion metrics, and a more diverse recruitment frame is recommended as a next step.

RESULTS AND DISCUSSION

Application Development

The Smart Diet Diary was implemented as a cross-platform mobile client in Flutter/Dart (Flutter Team, 2024) backed by a PHP server-side application exposing a Representational State Transfer Application Programming Interface, and a MySQL relational database. The implementation stack and integration choices are reported here at the level of detail relevant to scholarly reproducibility; lower-level routing, endpoint naming, and migration specifics are not rehearsed because they are not the substantive contribution of the study. Source-level artefacts and the User Requirements Specification are retained by the authors and can be shared on reasonable request.

System Capabilities

Onboarding and Authentication

Onboarding supports account registration with username, contact number, and a confirmed password, followed by role-aware login that routes the user to the parent/caregiver or nutritionist home view (Figures 2 and 3). The intent of including these views is to document that the prototype provides a complete end-to-end flow rather than to itemise screen behaviour.

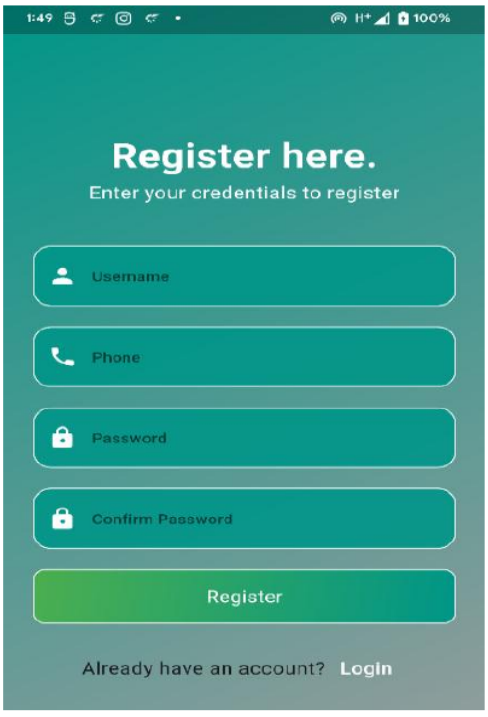

Figure 2: User (Parents) Registration Screen

Figure 3: User Login Screen

Nutritionist Diet Management

Nutritionist-facing screens (Figures 4–6) support authoring, listing, editing, and removal of dietary plans. Each plan record carries an age range, a weight range, a plan name, a description, and an associated food image, with authorship attribution. The decision to restrict authoring to nutritionist accounts is a governance choice rather than a technical one and is enforced at the role layer.

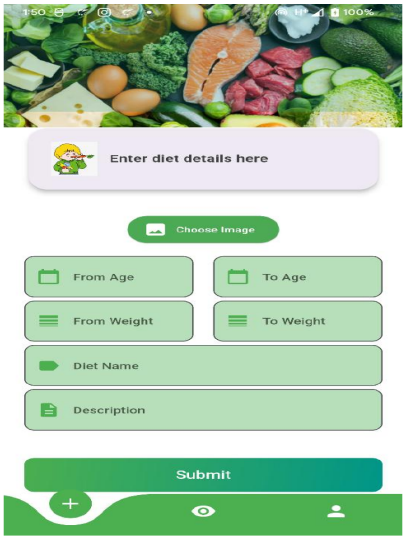

Figure 4: Nutritionist Add Diets Screen

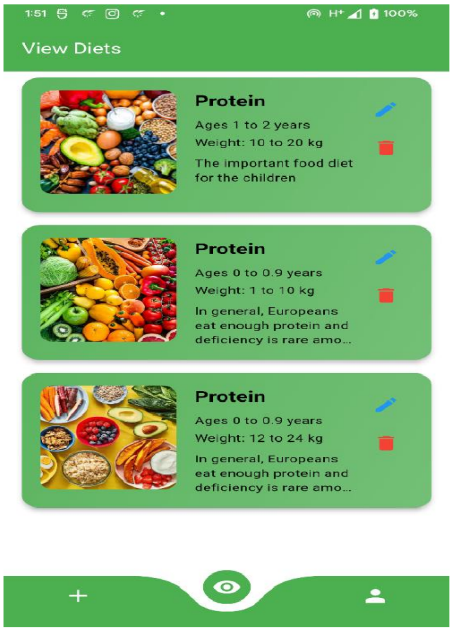

Figure 5: Nutritionist View Diets Screen

Figure 6: Nutritionist Edit Diets Screen

Dietary Guidance for Parents and Caregivers

The parent/caregiver retrieval flow (Figures 7–8) accepts the child's age and weight and returns plans whose authored age and weight ranges include those values, with an in-screen explanation

of the decimal age-encoding convention. The Diet Details view presents the selected plan together with its applicable age range, weight range, and authoring nutritionist. Retrieval is a deterministic rule-based lookup and is not an adaptive recommendation.

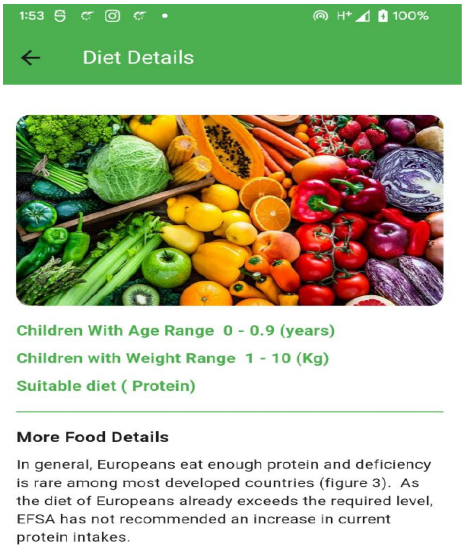

Figure 7: Diet Details Screen Screen

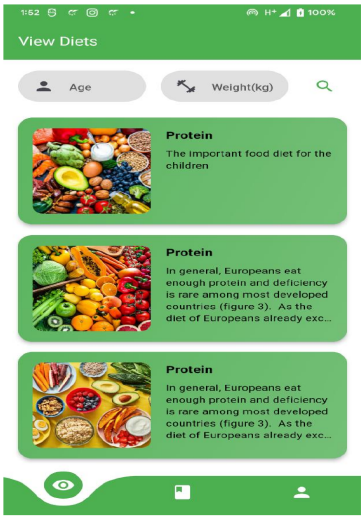

Figure 8: Parent/Caregiver View Diets

Profile and Session Management

The Profile screen (Figure 9) is available to all user roles and shows the logged-in user's username and contact details. A logout action terminates the session, which is important on shared household devices.

Figure 9: User Profile and Session Management Screen

Functional Testing Results

All five functional requirements derived from the use case design were exercised by the test cases and behaved as specified under expected-condition inputs. Table 1 summarises the outcomes. This section documents software functionality at the requirement level only; functional verification

does not demonstrate effectiveness of the dietary content, change in caregiver feeding behaviour, or impact on child growth.

Table 1: Summary of Functional Testing Outcomes

Functional Requirement	Expected Outcome	Result
User registration and login	Users can successfully register and access the application	Pass
Nutritionist: add diet details	Nutritionist can add new diet plans to the database	Pass
Nutritionist: view, update and delete diets	Nutritionist can view, edit and remove diet entries	Pass
Parent/caregiver: view diet details	Parents can browse and read dietary recommendations	Pass
User logout (all roles)	Both nutritionists and parents can securely log out	Pass

User Acceptance Testing Results

Twenty participants (15 parents/caregivers and 5 nutritionists) completed the UAT. Mean Likert scores (out of 5) and the share of responses in the 4–5 agreement band are summarised in Table 2.

Table 2: User Acceptance Testing – Mean Likert Scores (n = 20)

Evaluation Dimension	Mean Score (out of 5)	% Agreement (4–5)
Ease of use	4.5	90%
Content accuracy	4.6	95%
Interface clarity	4.4	90%
Perceived usefulness	4.7	95%
Overall satisfaction	4.6	95%

These scores indicate positive software-level acceptability among a small convenience sample of urban participants and are best read as preliminary acceptability indicators rather than as evidence of usability at scale or of intervention effectiveness. The numerical values are consistent with the upper end of acceptability reported in mHealth usability studies that have used standardised instruments, but are not directly comparable because the present instrument was investigator-developed rather than standardised. Parents and caregivers commented that having professionally curated dietary plans accessible on a phone was a useful complement to clinic-based advice, and nutritionists reported that the content-management interface lowered the effort required to keep dietary content up to date. These observations are participant feedback rather than evidence of changes in feeding behaviour or nutritional outcomes. The instrument was investigator-developed, the sample was urban and convenience-recruited, and no task-completion or error metrics were captured; the results motivate a larger, instrumented usability study (using the System Usability Scale and task-completion metrics) rather than a validated usability score.

What the Prototype Does, and What It Does Not Show

The principal output of this study is the Smart Diet Diary prototype itself: an end-to-end working application in which nutritionists author age- and weight-indexed dietary plans and caregivers retrieve plans matched to their child's parameters. Within the boundary conditions of the study (urban convenience sample, software-level testing only), the

work demonstrates that such a tool can be built and operated on accessible technology in Tanzania, and that intended end-users in this small sample found the prototype acceptable for the tasks tested. The study does not, and cannot from its design, demonstrate that use of the application changes infant and young child feeding practices, dietary diversity, growth trajectories, or stunting prevalence at the population level; the prototype is therefore reported as a software-level feasibility and acceptability artefact rather than as an intervention with measured behavioural or clinical outcomes.

Relationship to Existing mHealth Nutrition Work

Compared with the mHealth nutrition tools, the Smart Diet Diary occupies a deliberately narrow design space, and reading its results alongside the wider literature requires explicit analytical framing rather than a simple performance comparison. Three points of analytical contrast are worth setting out. First, unlike adult-oriented dietary tracking applications such as MyFitnessPal and Cronometer (Lieffers and Hanning, 2012), the prototype is built around caregiver-entered child parameters rather than self-reported food intake, sidestepping the dietary-recall accuracy issues that complicate the evidence base for those tools but trading them for a different limitation: the retrieval is only as informative as the granularity of the authored plan ranges. Second, unlike trial-tethered interventions such as those reported by Darawati et al. (2020) and Billah et al. (2017), the prototype is designed for routine caregiver self-service rather than as a study instrument operated by trained staff; this is a deployment-readiness contribution rather than an effectiveness contribution, and the evidence of effectiveness reported by those trial-embedded tools therefore cannot be inherited by the Smart Diet Diary on the strength of conceptual similarity. Third, compared with existing Tanzanian digital-health initiatives that have focused on Short-Message-Service information and community-health-worker workflow tools (Sabben et al., 2021; D-tree International, 2022), the prototype contributes a complementary mode: nutritionist-curated, structured dietary content retrievable via a smartphone interface, with content governance located within the nutrition profession rather than within a service-delivery workflow. Read against the broader mHealth usability literature (Maramba et al., 2019; Sondaal et al., 2016), the Likert-level acceptability scores reported here are within the upper acceptability range reported for early-stage prototypes evaluated on similarly small samples, but the absence of a standardised instrument and the absence of behavioural or task-completion measures mean the present results contribute to the design-feasibility evidence base rather than to the effectiveness evidence base. The novelty of the work is therefore a configurational claim (nutritionist governance + child-parameter retrieval + a locally referenced feeding knowledge base) rather than a claim of methodological novelty for mobile nutrition tools in general.

Policy Alignment

The study is consistent in design intent with the Tanzania National Multisectoral Nutrition Action Plan and with broad targets within Sustainable Development Goals 2 and 3. This alignment is positional rather than evidential: the prototype is consistent with these frameworks in intent, but does not measure population-level outcomes against any of their targets. Substantive contribution to those targets would require a separate, prospectively designed evaluation programme.

Limitations

The work reports software development and software-level acceptability only, with no clinical, behavioural, or anthropometric outcomes measured. Requirements were elicited from five urban nutritionists without direct caregiver interviews, so the study is not a full user-centred design exercise. The User Acceptance Test sample (n = 20) was urban and convenience-recruited from Dar es Salaam, leaving rural, lower-literacy, and low-connectivity users untested. The matching mechanism is a rule-based lookup on age and weight and does not account for allergies, illness history, household food availability, or longitudinal growth data. The prototype has not undergone a formal security audit; transport-layer encryption, encryption at rest, penetration testing, access-control review, ethical clearance, and a Data Protection Impact Assessment are required before any deployment that handles child-level data. The supporting literature review is a narrative review and does not meet systematic-review standards. Real-time caregiver–nutritionist messaging, identified as a high-value feature, is deferred to the next-iteration roadmap.

Future Work Agenda

Building on these limitations, the priority next-step activities are: (i) a participatory design phase that includes caregiver interviews and rural participants; (ii) a larger, instrumented usability study using SUS and task-completion metrics; (iii) a clinical impact evaluation, ideally a controlled prospective cohort study measuring IYCF adherence, dietary diversity, and child anthropometric outcomes over 6–12 months; (iv) ethical clearance through NIMR and the relevant university ethics committee and a data protection impact assessment under the Personal Data Protection Act (2022); (v) a formal security review including TLS, encryption at rest, and penetration testing; (vi) extension of the data model to support allergies, illness history, anthropometric trajectories, and household food availability; (vii) an offline mode for low-connectivity areas; and (viii) in-app messaging between caregivers and nutritionists.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This paper has presented the design, development, and software-level validation of the Smart Diet Diary, a mobile application that allows registered nutritionists in Tanzania to publish age- and weight-indexed dietary plans and enables caregivers to retrieve plans matched to their child's age and weight. The application was implemented using a Flutter/Dart mobile client, a PHP-based Representational State Transfer Application Programming Interface, and a MySQL backend, and developed using an Agile workflow within a Design Science Research strategy and an Object-Oriented Analysis and Design / Unified Modelling Language analysis approach. Functional testing confirmed that all five functional requirements behaved as specified under expected-condition inputs, and a small User Acceptance Test (n = 20) returned mean Likert scores of 4.4–4.7 out of 5 across ease of use, content accuracy, interface clarity, perceived usefulness, and overall satisfaction. The contribution is the prototype itself together with software-level evidence that a nutritionist-governed mobile dietary tool is technically feasible and preliminarily acceptable in a small urban Tanzanian sample. The study does not provide evidence of changes in feeding practices, dietary intake, or child growth, and effects on stunting prevalence, accessibility, or public-health outcomes are beyond its scope. Such evidence will require a separately designed clinical and behavioural evaluation, supported by ethical clearance, a Data

Protection Impact Assessment, and an expanded, rurally inclusive sample.

Recommendations

The recommendations arising from this study are appropriately cautious and grounded in the reported findings. Since requirements gathering relied on five urban nutritionists without direct caregiver interviews, the next iteration should incorporate participatory redesign involving caregivers, including rural and lower-literacy users. Given that the User Acceptance Test used a small convenience sample and a non-standardized instrument, a larger usability study using validated tools such as the System Usability Scale, together with task-completion and error metrics, is recommended. Before any caregiver-facing deployment, the prototype requires formal security assessment (including TLS, encryption at rest, penetration testing, and access-control review), a Data Protection Impact Assessment under the Personal Data Protection Act (2022), and ethical clearance from relevant authorities. As no clinical, behavioural, or anthropometric outcomes were measured, a prospective controlled evaluation should assess effects on feeding practices, dietary diversity, and child growth outcomes. Potential functional enhancements—such as offline capability, expanded dietary content, allergy and illness inputs, and caregiver–nutritionist messaging—should be co-designed with users. At this stage, broader deployment or advanced features such as machine learning are premature pending stronger empirical evidence.

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