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Master-Thesis

From Evidence to Innovation: Developing a Reward-Based mHealth Business Model for Video-Game-Playing Children and Adolescents

Submitted by Joseph Abasszada
Enrolment Number [redacted]
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1st Supervisor: Prof. Dr. York Zöllner

2nd Supervisor: Diploma (Bio-Eng) Tilman Möller

UNIVERSITY OF APPLIED SCIENCES HAMBURG

Faculty Life Sciences
M.Sc. Health Sciences
Department Health Sciences
Ulmenliet 20
21033 Hamburg

Abstract

Background: Physical inactivity is a leading global health challenge, contributing to 4-5 million preventable deaths annually. This issue often begins in youth, as activity patterns established during adolescence can persist throughout life; currently, 81% of adolescents fail to meet WHO recommendations, justifying early intervention. While mobile health interventions show promise, existing standalone reward-based approaches have demonstrated limited effectiveness in rigorous trials. The HealthGrind concept proposes embedding physical activity rewards into established video-game ecosystems to leverage youth motivations. This thesis evaluates the evidence for such mHealth interventions and develops a business model for this gaming-integrated approach in the German health market.

Methods: A systematic review searched PubMed for reward-based mHealth interventions promoting physical activity in children/adolescents (6-18 years) from January 2019 - March 2025. Risk of bias was assessed (RoB-2, ROBINS-I). Business model development used the Business Model Development Framework by Osterwalder and Pigneur (2013), supported by an environmental analysis of German market forces, industry dynamics, regulation, and macroeconomic conditions.

Results: Nine studies (n=7,747) applied virtual, social, financial, or altruistic rewards. Effectiveness inversely correlated with methodological quality: three large, low-bias RCTs reported null effects, while high-bias studies reported positive outcomes. All interventions used standalone applications, and none integrated rewards into gaming platforms. Business model analysis identified §140a SGB V Special Care Contracts as a potential viable pathway. The model relies on publisher partnerships and tiered B2C/B2B revenue streams, navigating a cost structure where platform fees and VAT absorb ~30% of gross revenue.

Conclusion: Rigorous trials show standalone reward-based mHealth apps are ineffective for youth. This thesis identifies a critical gap, as the potential of rewards integrated directly into gaming ecosystems remains empirically untested. The proposed business model's success hinges on securing game publisher partnerships, staged funding, and future RCT evidence to validate the approach within Germany's §140a SGB V framework

Keywords: mHealth interventions, physical activity, children and adolescents, video-games, reward mechanisms, digital health, business model, Germany, BMC

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Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
APP	Application
B2B	Business-to-Business
B2C	Business-to-Consumer
BfA	Federal Employment Agency
BfArM	Federal Institute for Drugs and Medical Devices
BMG	German Federal Ministry of Health
BMWK	German Federal Ministry for Economic Affairs and Climate Action
ChAd	Children and Adolescents
DiGAV	Digital Health Applications Ordinance
DSA	Digital Service Act
EHDS	European Health Data Space
EU	European Union
EXIST	Start-up Founding from Science
GDPR	General Data Protection Regulation
GKV-S	National Association of Statutory Health Insurance Funds
GmbH	Limited Liability Company
KfW	Credit Institute for Reconstruction
mHealth	Mobile Health
MVPA	Moderate-to-Vigorous Physical Activity
PA	Physical Activity
PICO	Population, Intervention, Comparison, and Outcomes
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCTs	Randomised Controlled Trials
RoB 2	Cochrane Risk of Bias Version 2
ROBINS-I	Risk Of Bias In Non-randomised Studies of Interventions
RQ1	Research Question 1
RQ2	Research Question 2
SES	Socioeconomic Status
SGB V	Social Code Book V
SHIs	Statutory Health Insurers
SWiM	Synthesis Without Meta-analysis
VAT	Value Added Tax
VC	Venture Capital
WHO	World Health Organisation
ZPP	Central Testing Centre for Prevention

1. Introduction

The Public Health and Economic Burden of Physical Inactivity

Physical inactivity has emerged as one of the most pressing challenges facing global public health systems in the 21st century. Defined as not meeting the World Health Organisation's (WHO) recommended guidelines for physical activity (PA), this behavioural risk factor is responsible for substantial morbidity and mortality worldwide (WHO, 2020a, p. 15). The severity of this issue is underscored by its contribution to an estimated four to five million preventable deaths annually and its status as the fourth leading risk factor for mortality from noncommunicable diseases (Kohl et al., 2012). The negative impact of insufficient PA extends across the entire lifespan, manifesting in distinct yet interconnected health outcomes for different age groups. In children and adolescents (ChAd), elevated sedentary behaviour correlates with increased adiposity, compromised cardiometabolic health, reduced physical fitness, and impaired behavioural conduct and sleep patterns (WHO, 2020a, p. 29). Among adults, high sedentary behaviour increases risks of all-cause mortality, cardiovascular disease, cancer mortality, and major noncommunicable diseases including type-2 diabetes (WHO, 2020a, p. 38). These widespread health consequences inevitably translate into substantial economic repercussions for healthcare systems and societies worldwide.

These health consequences generate substantial economic burdens on healthcare systems worldwide. In 2013, the worldwide economic impact of physical inactivity was estimated at approximately $67.5 billion (Ding et al., 2016). Of these costs, 58% were attributed to public healthcare expenditures, while the private sector and individual households shouldered the remaining 42%. Productivity losses contributed an additional $13.7 billion to this economic burden. Notably, high-income countries bear a disproportionate share of this financial impact, accounting for 80.1% of total healthcare expenditures linked to this preventable risk factor (Ding et al., 2016). Beyond these aggregate figures, the economic burden of physical inactivity exhibits significant demographic variation, with research indicating higher healthcare expenditures among older adults, suggesting that the health consequences of inactivity intensify across the lifespan (Gottschalk et al., 2025). This age gradient reinforces the necessity of promoting PA throughout all life stages, with longitudinal evidence indicating that activity patterns established in youth often persist into adulthood (OECD & European Commission, 2024, p. 58; Telama et al., 2005). The critical importance of early intervention is further emphasised by the observation that

81% of adolescents aged 11-17 globally do not meet WHO recommendations of at least 60 minutes of daily moderate-to-vigorous PA (MVPA) (WHO, 2022, p. 8).

From General mHealth Solutions to a Tailored Youth Intervention

Regular PA provides physiological benefits for ChAd, including reduced risks of excessive weight gain, enhanced bone density, and mitigated susceptibility to type-2 diabetes (PA Guidelines Advisory Committee, 2018, p. 380). Consequently, developing innovative strategies to enhance engagement represents a significant public health priority. Mobile health (mHealth) interventions have emerged as a promising approach, offering scalable and cost-effective solutions that transcend geographical barriers and permit real-time behavioural monitoring (WHO, 2011, p. 75). Meta-analytic evidence demonstrates their effectiveness in improving youth PA, with individualised mHealth interventions showing superior outcomes compared to standardised approaches (Baumann et al., 2022). The efficacy of universal, one-size-fits-all digital interventions remains limited, as such generalised approaches frequently fail to accommodate the diverse motivations and preferences of heterogeneous youth audiences, leading to poor engagement and high attrition rates (Schoeppe et al., 2017; Tong et al., 2021).

These limitations indicate a need for more tailored strategies targeting specific demographic subgroups. This thesis focuses on video-game-playing ChAd, defined as those engaging in leisure-based digital gaming across all platforms. This demographic exhibits high susceptibility to sedentary behaviour yet gaming itself provides motivational frameworks and social engagement opportunities that can be leveraged for health interventions (Franzkowiak, 2025, p. 76). While prolonged gaming contributes significantly to adolescent sedentary time and associates with decreased physical fitness (Puolitaival et al., 2020), existing approaches that merge PA with gaming typically require users to adopt new gaming products, whether location-based games such as Pokémon GO or dedicated exergames such as Ring Fit Adventure (Ozdamli & Milrich, 2023; Wu et al., 2022). In response to these considerations, the intervention conceptualised in this thesis proposes integrating PA rewards directly into established gaming routines.

HealthGrind: Theoretical Foundation and Prototype Evidence

The HealthGrind concept was developed to offer an alternative framework for acquiring digital goods in video-games, one that prioritises effort over monetary expenditure. Instead of spending significant in-game time or real-world money on items such as cosmetics, virtual currency, or advantageous benefits within games,

users can earn these rewards by engaging in PA in the real world. This model aims to target the motivational drivers of video-game players by transforming exercise into a productive and rewarding component of their existing gaming routines. It draws on self-efficacy theory to foster internal competence and self-regulation by allowing users to autonomously select and complete physical challenges, thereby earning rewards through their own effort (Bandura & Cervone, 1986, p. 92). This approach aligns with findings that video-game players are often driven by a desire for personal growth and meaningful progress within games, going beyond the search for mere entertainment (Possler et al., 2024). The selection of an effort-based framework is further justified by its specific alignment with the developmental characteristics of ChAd. Research in developmental cognitive neuroscience has shown that adolescence may be a period of increased willingness to expend physical effort during goal pursuit, as ChAd exhibit reduced sensitivity to effort costs compared to adults (Sullivan-Toole et al., 2019). The intervention's name and core principle, HealthGrind, are derived from grinding, a prevalent game mechanic wherein players perform repetitive tasks to earn in-game rewards (Rehbein et al., 2024). While often perceived as tedious, this mechanic is also associated with achievement and the perceived value of earned progress (Anderson & Johnson, 2021; Gibson et al., 2024). HealthGrind seeks to apply these same motivational dynamics to promote sustained PA.

Haghighi Fashi (2025) developed a functional prototype of this concept and tested it in a small-scale study as part of a bachelor's thesis, providing the conceptual foundation for this research. Implementation of this concept follows a four-step sequence: selecting a supported video-game, choosing from a variety of physical challenges, passively or actively verifying activity completion via a smartwatch application (APP), and receiving the corresponding reward (Haghighi Fashi, 2025, pp. 24–28). While the long-term vision includes direct application programming interface (API) integration with game publishers to enable seamless in-game reward delivery (Haghighi Fashi, 2025, p. 40), the prototype study demonstrated feasibility through an alternative reward mechanism. Participants selected their preferred game from those they were already actively playing and, upon completing the required number of PA challenges, received redeemable gift card codes that could be used to acquire in-game rewards within their chosen gaming environment (Haghighi Fashi, 2025, pp. 18–19). Initial findings indicated that video-game-related incentives served as effective motivational drivers for PA, though the study acknowledged limitations including a small sample size, budget constraints affecting reward mechanisms, and the temporal restrictions inherent in bachelor's thesis research (Haghighi Fashi, 2025,

p. 39). These initial findings demonstrate the potential effectiveness of leveraging gaming motivation for PA promotion, motivating further analysis of how mHealth interventions like HealthGrind can be positioned within the health sector.

Implementation Challenges: Gaming Industry Context and Market

HealthGrind's implementation faces substantial challenges within a gaming industry where dominant design approaches prioritise instant gratification over sustained effort, since many popular games prioritise revenue generation through prolonged user engagement rather than health or educational objectives (Petrovskaya & Zendle, 2022). This revenue-driven approach relies primarily on microtransactions, monetary transactions that allow players to bypass effort-based progression by purchasing instant rewards like virtual currency or game-advantageous benefits (Nicklin et al., 2021; Luo et al., 2023). This monetisation paradigm has been associated with problematic gaming behaviours and gambling-like tendencies, particularly through chance-based mechanics such as loot boxes (virtual containers with randomised in-game rewards) (Raneri et al., 2022). In this context, consumer protection organisations have raised concerns regarding manipulative design strategies targeting users with limited financial literacy and impulse control (BEUC, 2024).

Given these industry practices and regulatory concerns, HealthGrind proposes an alternative approach that prioritises effort-based progression, though this model must address the competitive challenges of operating within an ecosystem designed for instant gratification. Positioning such interventions within the health sector requires examination of specific market contexts and regulatory frameworks. Germany presents a particularly relevant case study, where only 26% of ChAd achieve WHO PA recommendations (Finger et al., 2018), yet near-ubiquitous ownership of mobile digital technologies provides the technical infrastructure necessary for mHealth implementation (MPFS, 2023, p. 26, 2024, p. 7). Moreover, microtransactions are particularly prevalent in the free-to-play and live-service games most popular among German ChAd, such as Fortnite, Roblox, and EA Sports FC (Jennewein et al., 2025, p. 16; MPFS, 2023, p. 56, 2024, p. 53), making these monetisation challenges directly relevant to this demographic.

Strategic Context: Positioning HealthGrind in the German Health Market

According to the conceptual framework of prevention, HealthGrind is classified as a primary prevention intervention because it targets healthy individuals to avert the initial onset of disease. The intervention aligns with this definition, as it is designed for a generally healthy population of ChAd, promoting PA to prevent or reduce the risk of

future noncommunicable diseases (Franzkowiak, 2025). Furthermore, HealthGrind is an example of behavioural prevention, as it seeks to directly influence individual health-related behaviours, specifically PA, by modifying the motivational drivers within the target group's existing gaming routines (Franzkowiak, 2025).

This classification determines its position within the German health market, which is characterised as either primary or secondary health market by the German Federal Ministry of Health (BMG) (BMG, 2025). Within the primary health market, characterised by statutory reimbursement, the Digital Health Applications Ordinance (DiGAV) legally defines the scope of eligible applications for reimbursements (DiGAV, 2020). However, as the official Guideline from the Federal Institute for Drugs and Medical Devices (BfArM) states, "primary preventive digital applications cannot be included in the directory" (BfArM, 2023, p. 23). For HealthGrind, this means the digital intervention does not meet the legal definition of a digital health application and is therefore ineligible for reimbursement by the DiGAV. Consequently, this thesis explores alternative market positioning strategies within the German health system, examining the prevention health market alongside other statutory and private funding mechanisms to identify viable pathways for implementation.

The development of HealthGrind therefore presents both scientific and business challenges. From a scientific perspective, the effectiveness of reward-based mechanisms in motivating youth PA requires systematic evaluation. From a business perspective, viable market positioning within Germany's health system demands understanding of regulatory constraints and revenue models.

Thesis Aims and Structure

This thesis addresses these dual challenges through two primary objectives. While the core mechanism of the proposed intervention relies on rewards, and preliminary evidence from a university student population suggests potential effectiveness (Haghighi Fashi, 2025, p. 29), it remains unclear whether reward-based mechanisms possess sufficient motivational potency to engage ChAd in PA. Therefore, the first objective is to systematically review the existing scientific literature on reward-based mHealth interventions to evaluate their effectiveness in promoting PA in youth. Second, the thesis aims to develop a viable business model for HealthGrind tailored to the German health market, one that can operate effectively within a digital landscape where immediate reward acquisition through payment has become the dominant paradigm.

This thesis is structured into six chapters. Following this Introduction, Chapter 2 defines the dual objectives: a scientific objective to systematically analyse reward-based mHealth interventions through a literature review, and a business objective to develop a business model blueprint for HealthGrind within the German health market. Chapter 3 presents the methodology, detailing the systematic literature review protocol and the business model development framework used to construct a Business Model Canvas. Chapter 4 reports the results, first presenting the systematic review findings, then the resulting Business Model Canvas components. Chapter 5 discusses the findings within the broader research landscape, identifies contributions and limitations, and outlines implications for practice and future research. Chapter 6 provides the conclusion, synthesising answers to the research questions and assessing the viability of the proposed business model blueprint.

2. Objective

Building on the challenges and opportunities identified in the introduction, this thesis pursues two interconnected objectives: a scientific objective addressed through a systematic literature review, and a business objective addressed through the development of a business model.

2.1 Scientific Objective

The scientific objective is to systematically analyse the existing literature on reward-based mHealth interventions aimed at increasing PA in ChAd. This analysis will evaluate the effectiveness of reward mechanisms in youth PA interventions while identifying design characteristics that may inform the development of the HealthGrind business model.

To achieve this objective, a systematic literature review will be conducted, guided by the following research questions:

Research Question 1 (RQ1): What types of rewards are employed in mHealth PA interventions targeting ChAd?

Research Question 2 (RQ2): What is the current evidence on the effectiveness of reward-based mHealth interventions for increasing PA in ChAd?

The findings from this review will provide an evidence-based foundation for the business model development objective.

2.2 Business Objective

The business objective is to develop a viable business model for the HealthGrind intervention within the German health market. This objective will culminate in a business model blueprint, a set of evidence-based hypotheses for each core component, rather than a fully operational business plan. The model must establish a sustainable value proposition and revenue structure that can operate effectively in business-to-consumer (B2C) contexts, targeting parents and adolescents with autonomous purchasing power, and/or business-to-business (B2B) contexts, engaging statutory health insurers (SHIs) and game publishers. The analysis will determine whether HealthGrind can operate within B2C models, B2B partnerships, or hybrid approaches combining both strategies.

A central component of this objective involves positioning an effort-based progression model within a gaming industry dominated by instant, paid-for rewards. The business model must therefore balance health sector positioning requirements with the competitive realities of the gaming industry. To structure this development process, established business model frameworks will be applied to systematically analyse market conditions and define core business components.

3. Method

This methodology section addresses both the scientific and business objectives outlined in Chapter 2. The scientific objective, to systematically analyse reward-based mHealth interventions for promoting PA in ChAd, will be addressed through a systematic literature review. The business objective, to develop a viable business model for HealthGrind within the German health market, will be addressed through an established business model framework.

The following sections describe both methodological approaches in detail, beginning with the systematic literature review.

3.1 Systematic Literature Review Methodology

The following systematic literature review was designed to address the research questions outlined in Chapter 2.1, particularly focusing on identifying the types of rewards employed in youth-targeted mHealth interventions and evaluating the effectiveness of these reward mechanisms in promoting PA among ChAd. To ensure transparency and reproducibility, this review follows the reporting structure of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework as outlined by Page et al. (2021). The methodological framework for

assessing risk of bias and synthesising findings is based on the Cochrane Handbook for Systematic Reviews of Interventions by Higgins et al. (2024).

3.1.1 Eligibility Criteria

The field of mHealth is characterised by multi-component interventions, where reward systems are often integrated as one of several features rather than being isolated variables. A narrow search focused exclusively on studies statistically isolating reward effects would exclude most relevant real-world applications. Consequently, eligibility criteria were intentionally defined broadly to ensure comprehensive coverage of the current landscape. This approach encompasses mHealth interventions incorporating tangible and intangible reward mechanisms, regardless of whether the study's primary analysis isolates reward effects from other intervention components. This strategy allows thorough assessment of how reward-based interventions are currently implemented and tested whilst preventing premature exclusion of novel approaches. Studies were selected for inclusion if they met criteria structured according to the Population, Intervention, Comparison, and Outcomes framework (PICO, Table 1).

Table 1 - PICO-Framework

PICO	Inclusion Criteria
Population	ChAd aged 6-18 years; general populations and at-risk groups (e.g., overweight, obesity)
Intervention	mHealth technologies (smartphone applications, wearable trackers) promoting PA with reward components (intangible: virtual goods such as badges or in-app currency; tangible: real-world incentives such as financial payments or prizes)
Comparison	Any comparison group (no-intervention, usual care) or no comparison group (single-arm studies)
Outcomes	PA measures (objective assessment via accelerometer or self-reported)

The lower age threshold of 6 years was selected based on evidence that smartphone ownership becomes prevalent from this age, with 44% of 6-7 year-olds possessing smartphones (MPFS, 2023, p. 26). Following the Robert Koch Institute definitions, children are defined as ages 6-13 years and adolescents as ages 14-17 years (Poethko-Müller et al., 2018, pp. 10–11). Studies including 18-year-olds were retained as they typically recruited across adolescent age ranges.

The search was limited to studies published between January 2019 and March 2025 to focus on contemporary mHealth approaches. This timeframe coincides with substantial growth in wearable device markets, with global sales increasing more than 16-fold compared to 2014 (Manz et al., 2025).

Exclusion criteria were applied to studies focusing on adult populations aged over 18 years or on adolescents undergoing treatment for severe illnesses (e.g., cancer). Interventions not targeting PA or lacking reward components as described in Table 1 were excluded. A critical distinction was made between rewards integral to the mHealth intervention and incentives offered solely for study participation. Only rewards designed to directly motivate PA behaviour were considered eligible. Incentives offered by researchers exclusively to encourage recruitment or retention were classified as methodological tools external to the intervention and therefore excluded. Non-English and non-German publications were also excluded to ensure accurate interpretation of study methods and findings. Study protocols without published outcome data were excluded, as they do not provide empirical evidence on intervention effectiveness. Additionally, secondary analyses of trials were excluded when the primary study was already included to avoid duplication of participant data. Grey literature, including conference abstracts, dissertations, and unpublished studies, was not systematically searched.

3.1.2 Search Strategy and Study Selection

Information Sources and Search Strategy

A systematic search of the PubMed electronic database was conducted on 15 March 2025. Search results were filtered using PubMed's study type limits to focus on higher-evidence study designs: clinical studies, clinical trials, comparative studies, evaluation studies, meta-analyses, randomised controlled trials, systematic reviews, and validation studies. This filtering approach was necessary to manage the broad motivational search strategy whilst prioritising methodologically robust evidence. The decision to search a single database represents a methodological limitation acknowledged in this thesis. Whilst multi-database searching is standard practice in comprehensive systematic reviews, the scope was constrained to PubMed due to resource and time limitations inherent in a master's thesis. PubMed was selected as it provides comprehensive coverage of biomedical and health sciences literature relevant to mHealth interventions.

The search combined key terms across five main concepts linked by the AND Boolean operator: population, PA and related behaviours, intervention types, technology and

rewards and motivation. To maximise retrieval of relevant studies, the search string employed synonyms and related terms within each concept, linked by the OR operator. Truncation using the asterisk symbol was utilised to capture word variations, such as teen* to retrieve teen, teens, and teenager. The population concept incorporated multiple terms describing ChAd, such as youth and school-age. The PA concept was broadened to include sedentary behaviour and screen time, as interventions targeting PA frequently address these related behaviours. The technology concept included specific device types, such as wearables and smartwatches, to capture mHealth interventions delivered through these platforms. The fifth search concept combined specific reward terms such as reward* with broader related terms including motivat*, gamif*, and behaviour change. This approach was adopted after preliminary searches using only reward-specific terminology yielded insufficient results, suggesting that reward mechanisms are often embedded within broader motivational or behaviour change interventions without explicit reward terminology in titles or abstracts. This deliberate balance between sensitivity and specificity enabled identification of interventions incorporating reward mechanisms as design features, followed by manual screening to confirm the presence and characteristics of reward systems within identified studies. The full search string used for PubMed is provided in Appendix A.

Study Selection Process

Search results were exported from PubMed as a .CSV file format and organised in a Microsoft Excel spreadsheet to facilitate systematic screening. The spreadsheet structured identified sources with sortable columns for title, authors, publication date, and digital object identifier.

Study selection was performed by a single reviewer (the author) in a multi-stage process. First, all titles were screened for relevance against eligibility criteria. Second, abstracts of potentially relevant articles were reviewed. Finally, full texts of remaining articles were retrieved and assessed in-depth against predefined eligibility criteria to make final inclusion decisions. During full-text screening, the presence of reward mechanisms was verified by searching for specific terms within the document text, including prize, medal, achievement, badge, incentive, coin, currency, leaderboard, point, financial, monetary, and cash. This systematic approach ensured consistent identification of reward components across studies. The reason for exclusion at each stage was documented in the spreadsheet. To supplement the database search, reference list screening was conducted by manually examining the included studies within relevant systematic reviews identified during the search process to identify

additional primary studies meeting this review's eligibility criteria. These supplementary studies were tracked separately with notation of their source review.

The single-reviewer approach represents a methodological limitation, as systematic reviews typically employ dual independent screening to reduce selection bias. This limitation was necessitated by the scope and resources of a master's thesis.

3.1.3 Data Extraction

Following study selection, data were systematically extracted from the full text of each included study using the expanded Excel spreadsheet. Extraction focused on information necessary to address the research questions, including study design characteristics, participant demographics, intervention features with particular attention to reward mechanisms, outcome measures, and reported findings.

The extracted data items were organised into four categories, as detailed in Table 2: study characteristics, participant characteristics, intervention and control group details, and outcomes and key findings. Data extraction accuracy was verified through multiple reviews of the Excel database by the author. This structured extraction process enabled systematic characterisation of included studies and synthesis of evidence addressing the review's research questions on reward types employed in youth mHealth PA interventions and their effectiveness.

Table 2 - Extracted Study Data

Category	Extracted Data Items
Study Characteristics	Author and publication year; Country of origin; Study design; Length of the active intervention period; Follow-up timepoints
Participant Characteristics	Total number of participants (N); Age range and/or mean age; Population description (e.g., general population, overweight or obesity)
Intervention and Control Group Details	Official name of the mHealth application or intervention programme; Technology platform (web-based, application (APP), wearable device); Description of comparison or control group
Outcomes and Key Findings	Outcomes relevant to PA; Method used to measure PA; Statistical findings (e.g., 95% confidence intervals, p-values)
Reward Mechanisms	Type of reward; Detailed description of how rewards were implemented and earned

3.1.4 Risk of Bias Assessment

The methodological quality of included studies was assessed to identify potential sources of bias. Due to time and resource constraints inherent in a master's thesis, a simplified bias assessment approach was employed.

For randomised controlled trials, assessment was informed by the Cochrane Risk of Bias Version 2 (RoB 2) framework, evaluating five key domains: randomisation process, deviations from intended interventions, missing outcome data, outcome measurement, and selective reporting (Sterne et al., 2019, p. 2). For non-randomised studies, assessment was guided by the Risk Of Bias In Non-randomised Studies of Interventions (ROBINS-I) framework, evaluating seven domains: bias due to confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of reported results (Sterne & Higgins, 2024, p. 1).

Each domain was assigned a judgement based on information reported in the studies. For randomised controlled trials (RCTs), judgements were Low Risk, Some Concerns, or High Risk (Sterne et al., 2019, pp. 3–4). For non-randomised studies, judgements were Low Risk, Moderate Risk, Serious Risk, or Critical Risk (Sterne & Higgins, 2024, p. 2). An overall risk of bias judgement was assigned based on the highest risk level across domains, with brief justification provided for this overall rating.

This assessment was conducted by a single reviewer without dual independent assessment, comprehensive signalling question protocols, or detailed documentation of domain-level rationales. These represent significant methodological limitations. The simplified approach prioritised identifying major sources of bias whilst acknowledging that comprehensive bias assessment following complete RoB 2 and ROBINS-I protocols was not feasible within the thesis scope. Results are presented in tabular format with colour coding in the Results chapter.

3.1.5 Synthesis Methods

Statistical meta-analysis was not feasible due to substantial heterogeneity across included studies, which varied in intervention designs, reward mechanisms, target populations, and PA outcome measures. The synthesis was therefore structured following the Synthesis Without Meta-analysis (SWiM) reporting guideline by Campbell et al. (2020), which served as a methodological framework for enhancing transparency whilst acknowledging that resource constraints precluded implementing all SWiM recommendations.

The primary analytical task was synthesising evidence on reward types employed in youth mHealth interventions (RQ1) and their effectiveness in promoting PA (RQ2). To address RQ1, reward mechanisms from each study were qualitatively categorised based on their motivational characteristics through inductive analysis of the extracted data. To address RQ2 and explore whether effectiveness patterns differed by incentive strategy, studies were thematically grouped by their primary reward mechanism (SWiM Item 3). Within these groups, findings were standardised by classifying the primary PA outcome into a direction of effect: Positive, Negative, No Effect, or Unclear, based on predefined decision rules presented in Table 3 (SWiM Item 5).

Table 3 - Definition of Direction of Effect Classification

Direction of Effect	Definition
Positive	The intervention group demonstrated statistically significant improvement in PA compared to baseline or control group
Negative	The intervention group demonstrated statistically significant worsening in PA compared to baseline or control group
No effect	No statistically significant difference was found between groups or from baseline to follow-up
Unclear	Results were qualitative, not tested for significance, or primary outcome was not a direct measure of PA

Synthesis of effectiveness evidence involved critical appraisal rather than vote counting (SWiM Item 7). Greater interpretive weight was given to findings from studies with lower risk of bias. This weighting reflected qualitative judgement during narrative synthesis rather than a formal quantitative system. The complete synthesis is presented textually in the Results section, supported by summary tables providing transparent linkage between individual study data and overall conclusions (SWiM Item 9).

3.2 Business Model Development Methodology

The second objective of this thesis is to develop a viable business model for the HealthGrind intervention, tailored to the German secondary health market. The process employs the Business Model Development Framework by Osterwalder and Pigneur (2013). The methodology involves comprehensive environmental analysis, synthesis of findings, and construction of a Business Model Canvas. This Canvas serves as the business model blueprint, comprising evidence-based hypotheses for

each of the nine core building blocks that systematically define how an organisation creates, delivers, and captures value.

3.2.1 Rationale for Framework Selection

The development of a business model for a service-focused digital health intervention requires a structured analytical framework (Diment et al., 2024). For this purpose, the Business Model Canvas was selected due to its documented utility in the scientific field of digital health. A systematic review by Velayati et al. (2022) identified the Osterwalder and Pigneur framework as one of the most frequently used tools for analysing digital health interventions, demonstrating its recognition as a standard methodological tool in this domain. Its utility has been demonstrated in applied mHealth research, where it has been used as an analytical instrument to structure stakeholder analysis and ensure that a resulting business model is comprehensively aligned with the needs of the healthcare environment (Korsgaard et al., 2021; Van Limburg et al., 2015). This established framework is particularly suited to this thesis, as it enables systematic evaluation of the HealthGrind concept across its nine constituent domains, supporting the development of a coherent business model grounded in market reality and academic precedent (Mahtab et al., 2025).

3.2.2 Environmental Analysis

A business model must be designed in alignment with its specific external environment. Consequently, the first methodological step is a comprehensive environmental analysis to identify the external "design drivers" and "design constraints" that shape the strategic landscape for HealthGrind (Osterwalder & Pigneur, 2013, p. 200). As illustrated in Figure 1, this analysis directly influences the development of the nine building blocks of the Business Model Canvas through four key domains:

Market Forces analysis identifies key factors transforming the market from customer and value proposition perspectives (Osterwalder & Pigneur, 2013, p. 202). This is conducted by synthesising academic literature on stakeholder categories and behavioural profiles, industry reports on gaming monetisation and revenue trends, market research on parental attitudes, and legal documents defining the B2B healthcare market in Germany.

Industry Forces analysis examines the competitive landscape, including incumbent competitors, potential new entrants, and key suppliers (Osterwalder & Pigneur, 2013, p. 204). To conduct the competitor analysis, a structured scan of the top 100 ranked applications in the 'Health & Fitness' category of the Apple iOS APP Store was

performed on August 21, 2025. Applications were deemed eligible if they were accessible to ChAd (age rating below '17+') and incentivised behaviour with tangible rewards such as financial incentives or gift cards. Furthermore, the analysis involves reviewing industry news to identify potential new entrants from adjacent sectors and examining existing digital ecosystems to understand supplier power and partnership precedents.

Key Trends analysis identifies major technological, regulatory, sociocultural, and socioeconomic trends (Osterwalder & Pigneur, 2013, p. 206). This is conducted by reviewing scientific literature for technological and sociocultural patterns, quantitative survey data for socioeconomic trends, and a detailed examination of formative European Union (EU) and national regulations.

Macroeconomic Forces analysis outlines the broader economic context, including capital markets and economic infrastructure (Osterwalder & Pigneur, 2013, p. 208). This is based on a review of current economic reports and statistical data from national and international economic institutions (e.g., European Commission, Destatis), detailed national labour market analyses, and government strategy documents outlining public funding and venture capital frameworks.

Following the environmental analysis, a domain-specific synthesis is conducted for each of the four key domains (Market Forces, Industry Forces, Key Trends, and Macroeconomic Forces). Each synthesis translates domain-specific findings into strategic implications for the HealthGrind business model. These four syntheses are subsequently consolidated to inform foundational design decisions that structure the Business Model Canvas.

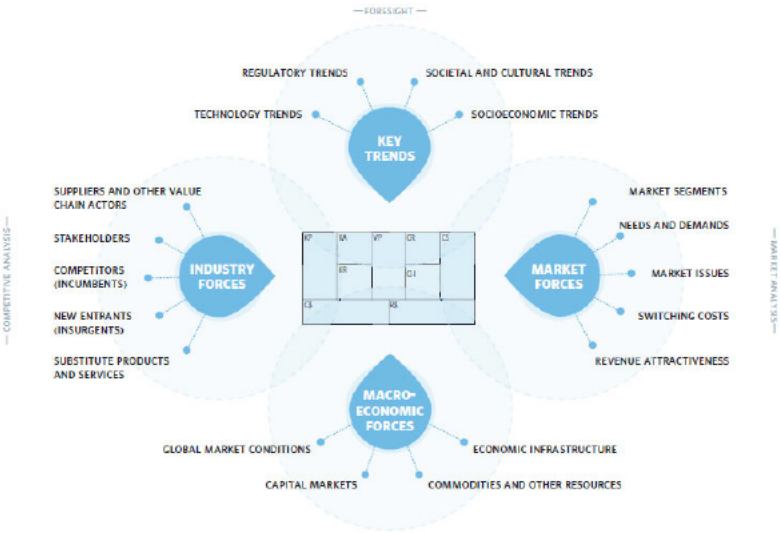

Figure 1 - The four dimensions which are intercorrelated and impacting the Business Model Canvas in the centre (Osterwalder & Pigneur, 2019, p. 201)

3.2.3 Foundational Design Decisions

The environmental analysis and domain-specific syntheses generate strategic implications that require resolution into concrete design parameters before Business Model Canvas construction. This methodological step addresses fundamental architectural choices that define the business model's structure. The process involves evaluating competing strategic options against the constraints and opportunities identified in the synthesis findings. Each foundational decision represents a binary or categorical choice between structurally distinct approaches (e.g., regulatory pathway selection, partnership versus self-funded models). These decisions are documented with explicit justification derived from the environmental analysis, acknowledging where choices rest on unvalidated assumptions requiring future empirical testing.

The output of this step is a set of documented strategic commitments that establish the boundary conditions within which the nine Canvas building blocks are subsequently developed. This ensures that Canvas construction occurs within a coherent strategic framework rather than as isolated component design.

3.2.4 Business Model Canvas

The concluding step is the construction of the Business Model Canvas itself. Drawing from the foundational design decisions established in Chapter 3.2.2 and 3.2.3, each of the nine building blocks is developed within the defined strategic framework and syntheses. For the purposes of this thesis, the Canvas is presented in a descriptive, written format through detailed, descriptions of each building block, as outlined in Table 4.

Table 4 - Building Blocks of the Business Model Canvas

Building Block	Definition
Customer Segments	The distinct groups of people or organisations the enterprise aims to serve
Value Propositions	The specific bundle of products and services that create value for each customer segment
Channels	The means by which the enterprise communicates with and delivers value to its customers
Customer Relationships	The types of relationships established and maintained with each customer segment
Revenue Streams	The ways in which the enterprise generates income from its value propositions
Key Resources	The essential assets required to offer and deliver the value proposition
Key Activities	The critical actions the enterprise must perform to operate successfully

Key Partnerships	The network of external suppliers and partners that make the business model work
Cost Structure	All costs incurred to operate the business model

4. Results

4.1 Systematic Literature Review

4.1.1 Study Selection

The study selection process is summarised in the PRISMA 2020 flow diagram (Figure 3). The initial PubMed database search on 15 March 2025 yielded 158 records. As no duplicates were identified, all 158 records underwent title and abstract screening, resulting in exclusion of 109 records that failed to meet eligibility criteria, primarily due to focus on adult populations.

Full texts were sought for the remaining 49 articles, of which 48 were successfully retrieved and 1 could not be obtained. The 48 retrieved articles were assessed for eligibility. At full-text screening, 44 articles were excluded for the following reasons: systematic review format (n=22), absence of reward components (n=10), study protocol without outcome data (n=4), secondary analysis of included primary studies (n=4), non-mHealth intervention (n=2), or intervention not targeting PA (n=2). This process resulted in 4 studies included from the database search.

The 22 excluded systematic reviews were subsequently used for supplementary reference list screening. Manual examination of studies included within these reviews identified 7 potentially eligible studies. Following full-text assessment, 2 studies were excluded as they did not meet eligibility criteria. Reference list screening yielded 5 additional studies for inclusion.

In total, 9 studies from both the database search and reference list screening met all inclusion criteria and were included in the systematic review.

4.1.2 Characteristics of included Studies

Study Design, Duration and Geographical Distribution

The nine included studies (Table 5) comprised five RCTs, two single-arm studies, one quasi-experimental study, and one quasi-randomised controlled trial. The RCTs included two cluster RCTs (Corepal et al., 2019; Wunsch et al., 2020) and three individually randomised trials (Champion et al., 2023; Stasinaki et al., 2021; Tugault-Lafleur et al., 2023). Both single-arm studies (Cummings et al., 2022; Schoeppe et al., 2020) employed pre-post designs without control groups. The quasi-experimental study (Duck et al., 2021) utilised a non-equivalent control group design, whilst the

quasi-randomised trial (Peuters et al., 2024) allocated participants using pre-existing groups. Four studies explicitly identified feasibility or preliminary effectiveness as primary aims (Corepal et al., 2019; Cummings et al., 2022; Duck et al., 2020; Schoeppe et al., 2020).

Participant Characteristics

The combined sample across all nine studies included 7,747 participants, though sample sizes varied considerably from 28 participants (Cummings et al., 2022) to 6,640 participants (Champion et al., 2023). The large sample in Champion et al. reflected its cluster-randomised design involving multiple schools. The median sample size was 156 participants.

The studies encompassed both children and adolescents. For those reporting a mean age, the values ranged from 8.0 to 14.81 years. Three studies focused on children: Duck et al. (2020) recruited participants with a mean age of 9.2 years, Schoeppe et al. (2020) included children with a mean age of 8.0 years, and Champion et al. (2023) included children with a mean age of 12.7 years within an 11-13-year age range. The remaining six studies recruited mixed samples of ChAd. These studies had broad age ranges that spanned both categories: 12-14 years (Corepal et al., 2019), 13-18 years with a mean age of 14.81 years (Cummings et al., 2022), 12-15 years with a mean age of 13.63 years (Peuters et al., 2024), 10-18 years (Stasinaki et al., 2021), 10-17 years with a mean age of 12.8 years (Tugault-Lafleur et al., 2023), and participants older than 10 years with a mean age of 13.3 years (Wunsch et al., 2024). The family-based interventions by Schoeppe et al. (2020) and Wunsch et al. (2024) were unique in including both children and their parents as intervention recipients. Five studies recruited from general school-based or general populations without specific health criteria (Champion et al., 2023; Corepal et al., 2019; Duck et al., 2020; Peuters et al., 2024; Wunsch et al., 2024). Three studies specifically targeted adolescents with overweight or obesity, defined as body-mass-index >90th percentile (Cummings et al., 2022; Stasinaki et al., 2021; Tugault-Lafleur et al., 2023). One study recruited families self-identifying as insufficiently active at baseline (Schoeppe et al., 2020).

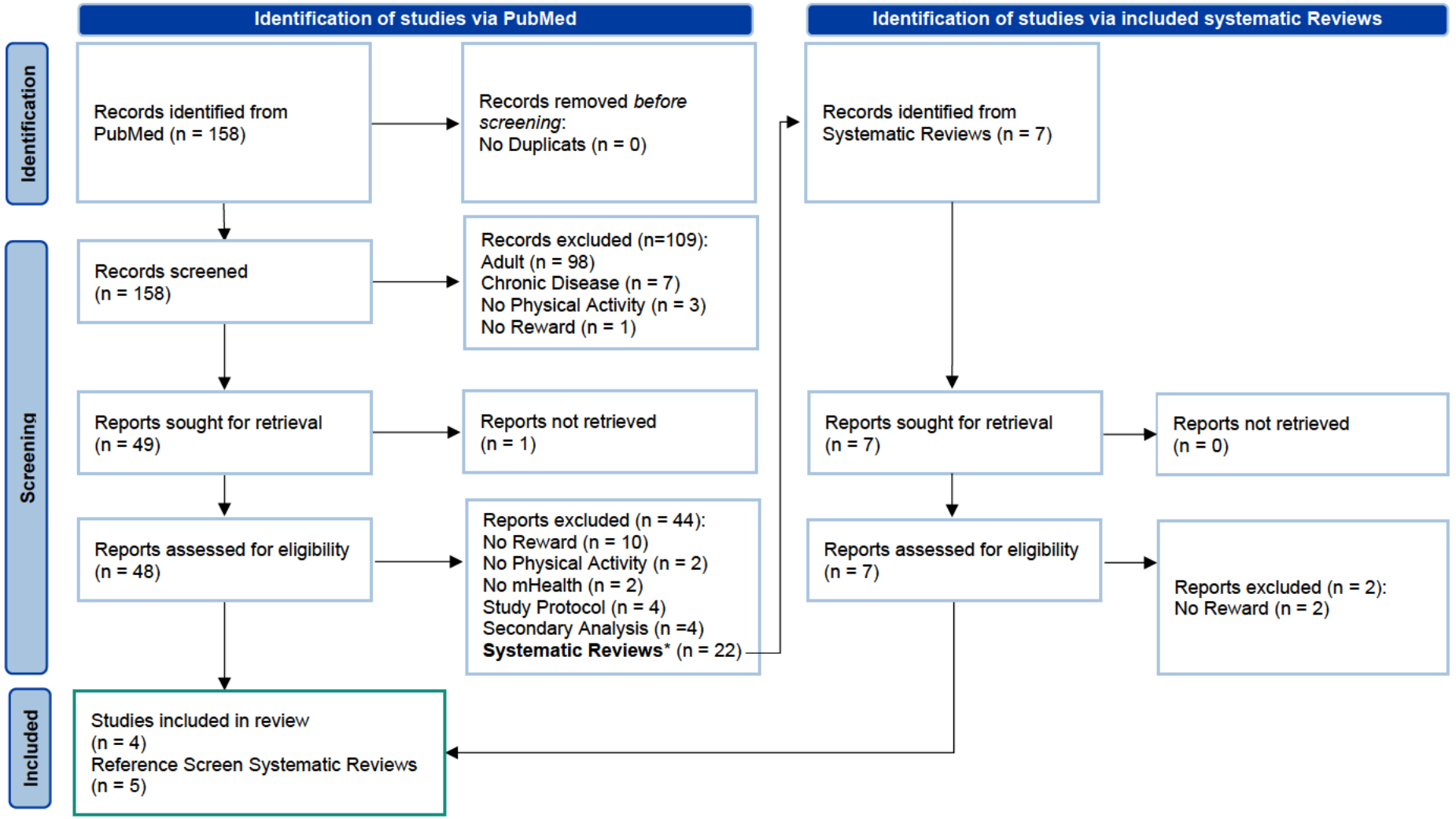

Figure 2 - PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and systematic reviews (Page et al., 2021)

Table 5 - Data-Extraction of the Systematic Review

Study	Country	Rewards	N	Age	Population	Duration	Timepoint	Design	Control	Intervention Name	PA Measured Outcome
Champion et al. 2023	Australia	Badges; Medals; Peer-Competition; Tally Leaderboard	6640	11-13 years (mean = 12.7)	General (school-based)	6 weeks	Baseline, 12 months, 24 months	RCT	Active Control	Health4Life (web-based and APP)	Days with ≥60 min MVPA
Corepal et al. 2019	Northern Ireland	Vouchers (£10); goody bags (£30); Leaderboards; £1000 prize; Badges	224	12-14 years	General	22 Weeks	Baseline, 8 weeks, 22 weeks, 52 weeks	cRCT F	No-Intervention Control	StepSmart Challenge (web-based and Fitbit APP with Wearable)	Daily minutes of MVPA, steps, light, moderate, and vigorous PA
Cummings et al. 2022	United States	Cash on a reloadable debit card (up to $510)	28	13-18 years (mean = 14.81)	Overweight or obesity	12 Weeks	Baseline, 12 weeks	SA F	None	No Name - (SMS Messages and Fitbit APP with Wearable)	Active minutes, steps, body fat %, body mass
Duck et al. 2020	United States	Points for UNICEF food for children	35	Mean = 9.2 years	General	10 Weeks	Baseline, 10 weeks	QE F	Waitlist Control	Kid Power Bands (web-based and APP with Wearable Integration)	Average daily MVPA minutes, cardiorespiratory fitness
Peuters et al. 2024	Belgium	Coins for avatar customisation	279	12-15 years (mean = 13.63)	General / *Physically Active*	12 Weeks	Baseline, 6 weeks, 12 weeks	qRCT	No-Intervention Control	#LIFEGOALS (APP with Wearable Integration)	Overall activity volume (device-measured), sedentary minutes
Schoeppe et al. 2020	Australia	Coins for App Progression; Family Leaderboard	130	Mean = 8.0 years & Parents	Insufficiently Active Families	6 Weeks	Baseline, 6 weeks	SA F	None	Step it Up Family (Garmin app with Wearable)	MVPA (min/day or week), steps, active minutes, % meeting guidelines
Stasinaki et al. 2021	Switzerland	Smartphones awarded; Virtual Keys; peer-competition	41	10-18 years	Overweight or obesity	24 Weeks	Baseline, 24 weeks, 12 months	RCT	Active Control	PathMate2 (APP with virtual coach)	Muscle mass, body fat %, physical capacities, weight loss
Tugault-Lafleur et al. 2023	Canada	Currencies (Progression & Collectibles)	214	10-17 years (mean = 12.8)	Overweight or obesity	26 Weeks	Baseline, 13 weeks, 26 weeks	RCT	Waitlist Control	Aim2Be (APP with Wearable integration)	Daily steps, PA minutes/week (school & outside), body mass
Wunsch et al. 2024	Germany	Stars collected as a family unit	156	>10 years (mean = 13.3) & Parents	General population	3 Weeks	Baseline, 3 weeks, 7 weeks	cRCT	No-Intervention Control	SMARTFAMILY (APP with Wearable integration)	MVPA (min/week), steps (per week), family joint PA (activities/week)

For readability the following abbreviations have been conducted: single-arm (SA), quasi-experimental (QE), quasi-randomised controlled trial (qRCT) cluster (c), feasibility (F)

In contrast, Wunsch et al. (2024) intentionally recruited a highly active cohort with baseline MVPA exceeding recommendations, whilst Peuters et al. (2024), despite recruiting from the general adolescent population, unexpectedly found participants averaging 122 minutes of daily MVPA, double the recommended 60 minutes.

Intervention Characteristics and Technology Platforms

All nine interventions utilised digital health technologies, with variation in the specific platforms and hardware employed. Platforms included web-based systems, mobile applications, or a combination of both. APPs were either purpose-developed for the study or utilised existing third-party platforms provided by wearable device manufacturers. Six studies employed purpose-developed applications: two without reported wearable integration (Champion et al., 2023; Stasinaki et al., 2021) and four with wearable integration (Duck et al., 2020; Peuters et al., 2024; Tugault-Lafleur et al., 2023; Wunsch et al., 2024). The remaining three studies utilised third-party platforms from wearable device manufacturers without developing custom APPs (Corepal et al., 2019; Cummings et al., 2022; Schoeppe et al., 2020). In total, seven of the nine studies incorporated wearable devices for PA tracking.

Physical Activity Measurement

PA outcomes were assessed through four methodological approaches: device-based measurement alone (four studies), combined device-based and self-reported measurement (three studies), self-reported measurement alone (one study), and fitness test assessment (one study).

Device-based measurement only was employed in four studies (Corepal et al., 2019; Cummings et al., 2022; Duck et al., 2020; Peuters et al., 2024) using wearable devices such as accelerometers, Fitbits, or Garmin watches. Measured outcomes included MVPA, daily step counts, active minutes, and sedentary time, with Corepal et al. (2019) additionally distinguishing between light, moderate, and vigorous PA intensities. Combined device-based and self-reported measurement was employed in three studies (Schoeppe et al., 2020; Tugault-Lafleur et al., 2023; Wunsch et al., 2024). Schoeppe et al. (2020) combined Garmin wearable device data with parent-reported MVPA for children and self-reported data for parents. Tugault-Lafleur et al. (2023) supplemented device-measured daily steps with self-reported physical activity minutes. Wunsch et al. (2024) combined device-measured MVPA and steps with self-reported family joint PA.

Self-reported measurement alone was employed by Champion et al. (2023), who assessed days per week participants engaged in at least 60 minutes of MVPA through

adolescent questionnaires. Fitness test assessment was employed by Stasinaki et al. (2021), who assessed physical fitness capacities through a standardised fitness test (Dordel-Koch-Test) rather than measuring direct PA metrics.

Reward Components

The interventions employed diverse reward components to motivate participants. Following the inductive analytical approach outlined in Chapter 3.1.5, these rewards were categorised into four types based on their primary motivational characteristics: virtual, social, financial/prize-based, and altruistic incentives.

Virtual rewards appeared in seven of the nine studies. These included digital badges (Champion et al., 2023; Corepal et al., 2019), virtual coins or in-game currency (Peuters et al., 2024; Schoeppe et al., 2020; Tugault-Lafleur et al., 2023), stars collected as a family unit (Wunsch et al., 2024), and virtual keys (Stasinaki et al., 2021). Virtual currency was used to unlock content, such as adventure story progression within APPs (Schoeppe et al., 2020; Tugault-Lafleur et al., 2023), or to customise personal avatars (Peuters et al., 2024).

Social rewards, often leveraging competition, were incorporated into four studies (Champion et al., 2023; Corepal et al., 2019; Schoeppe et al., 2020; Stasinaki et al., 2021). These often-included leaderboards for individual or team competitions.

Three studies utilised tangible financial or prize-based rewards. Cummings et al. (2022) provided direct cash incentives on a reloadable debit card for meeting weekly goals. Corepal et al. (2019) offered vouchers, goody bags, and a cash prize for the winning school. Stasinaki et al. (2021) awarded five smartphones to the most successful participants.

Finally, one study implemented a unique altruistic reward system. In the intervention by Duck et al. (2020), participants earned Power Points through PA, which could be redeemed for UNICEF food packs to be sent to malnourished children in the global south.

4.1.3 Risk of Bias Assessment

The risk of bias assessment identified methodological concerns across all nine included studies, with substantial variation in overall judgement severity. Results are presented separately for randomised controlled trials and non-randomised studies.

Risk of Bias in Randomised Controlled Trials (RoB 2)

Five studies were identified as randomised controlled trials and were assessed using the RoB 2 framework. The assessment covered five domains: randomisation process

(rD1), deviations from intended interventions (rD2), missing outcome data (rD3), outcome measurement (rD4), and selective reporting (rD5). An overall judgement (rR) was assigned based on the highest level of concern across these domains. The detailed results are presented in Table 6.

The overall risk of bias for the RCTs ranged from 'Some Concerns' to 'High Risk'. Three studies (Champion et al., 2023; Tugault-Lafleur et al., 2023; Wunsch et al., 2024) were rated as having 'Some Concerns'. Common issues leading to this judgement included a lack of blinding for participants and personnel for self-reported outcomes and potential contamination of the control group. Two studies were evaluated as being at high risk of bias, primarily due to substantial attrition in one study (Stasinaki et al., 2021) and the absence of formal effectiveness testing in the other, which was justified by its feasibility-study design (Corepal et al., 2019). These methodological limitations must be considered when interpreting effectiveness findings from these studies.

Table 6 - Risk of Bias RoB 2

Study	rD1	rD2	rD3	rD4	rD5	rR	Justification
Champion et al. 2023							25% dropouts at 24 months, lack of blinding for self-reported outcomes
Corepal et al. 2019							Missing wearable data (43%) at timepoint 52 weeks, outcome not tested on effectiveness
Stasinaki et al. 2021							High attrition and missing outcome data (24% dropouts in the beginning of the study)
Tugault-Lafleur et al. (2023)							Lack of blinding and control group contamination led to behaviour change
Wunsch et al. (2024)							Lack of blinding for participants and missing outcomes

Colour Code: green = low risk, yellow = some concerns, red = high risk

Risk of Bias in Non-Randomised Studies of Interventions (ROBINS-I)

One study self-identified as a quasi-randomised controlled trial (Peuters et al., 2024) but was reclassified for this assessment as a non-randomised study requiring ROBINS-I assessment. This classification was necessary because the study did not employ a true random chance process for allocation. Instead, group assignment was determined by a systematic, rule-based method where "the school with the highest number of selected students was assigned to the intervention group" (Peuters et al., 2024, p. 4). This approach is consistent with the RoB 2 guidance, which confirms that allocation methods, referred to as “quasi-random”, are inadequate for sequence

generation, suggesting that such studies should be treated as non-randomised and assessed using the ROBINS-I tool (Sterne & Higgins, 2024, pp. 12, 15).

Including Peuters et al. (2024) alongside the three studies originally identified as non-randomised designs (Cummings et al., 2022; Duck et al., 2020; Schoeppe et al., 2020), four studies in total were assessed using a framework guided by ROBINS-I. The assessment evaluated seven domains: confounding (D1), participant selection (D2), intervention classification (D3), deviations from intended interventions (D4), missing data (D5), outcome measurement (D6), and selection of reported results (D7). Domain-specific judgements, overall risk of bias ratings, and justifications for overall judgements are summarised in Table 7.

The non-randomised studies were generally found to have a higher risk of bias, with judgements ranging from 'Serious Risk' to 'Critical Risk'. Two studies (Cummings et al., 2022; Schoeppe et al., 2020) were rated as having a 'Critical Risk' of bias. This was primarily due to confounding from their single-arm, pre-post design, which makes it impossible to attribute observed changes solely to the intervention. The other two studies (Duck et al., 2020; Peuters et al., 2024) were judged to be at 'Serious Risk', with major concerns related to confounding from non-random participant selection, baseline imbalances between groups, and high rates of missing data. The high risk of bias in non-randomised studies substantially limits confidence in causal inferences regarding intervention effectiveness.

Table 7 - Risk of Bias Assessment ROBINS-I

Study	D1	D2	D3	D4	D5	D6	D7	R	Justification
Cummings et al. 2022									The absence of a control group prevents attributing observed improvements solely to the intervention
Duck et al. 2020									Participant selection by principals who were also in the study created a high potential for confounding
Peuters et al. 2024									Confounding from baseline imbalances, systematic non-random selection of participants, missing objective outcome data
Schoeppe et al. 2020									Confounding from its single-arm design and measurement bias from self-reported outcomes

Colour Code: green = low risk, yellow = moderate risk, orange = serious risk, red = critical risk

4.1.4 Synthesis of Findings

This synthesis addresses the two research questions guiding this systematic review: the types of rewards employed in mHealth PA interventions targeting ChAd (RQ1), and the current evidence on the effectiveness of these reward-based interventions (RQ2). Following the analytical approach outlined in Chapter 3.1.5, studies were

categorised by their primary reward mechanism, and effectiveness evidence was synthesised together with critical appraisal of findings weighted by risk of bias (Table 8).

Table 8 - Synthesis of findings with critical appraisal

Studies	B	Reward Type	Measurement	PA Measured Outcome	PA Statistical Findings	Direction of Effect
Champion et al. 2023		Virtual, Social	Self-Reported	MVPA	No between-group difference in MVPA (OR = 0.82; 95% CI [0.62 to 1.09])	No effect
Corepal et al. 2019		Financial/Prize, Virtual, Social	Wearable	MVPA	No testing for effectiveness	Unclear
Cummings et al. 2022	*	Financial	Wearable	Active minutes and Steps	Active minutes: +20.41 min/day (p=.006) Tracked Steps: +924 steps/day (p<.001)	Positive effect
Duck et al. 2020	*	Altruistic	Wearable	MVPA	Non-significant decrease in MVPA in both groups	No effect
Peuters et al. 2024	*	Virtual	Wearable	Device measured PA and sedentary time	PA increased (X^2 = 4.36, p=.04) and sedentary time decreased (X^2= 6.44, p=.01)	Positive effect
Schoeppe et al. 2020	*	Virtual, Social	Wearable & Proxy-Reported (Parents)	MVPA	MVPA: +58 min/day, (p<0.001)	Positive effect
Stasinaki et al. 2021		Prize, Virtual, Social	Dordel-Koch-Test	Physical capacities	Both groups improved physical capacities (p<0.05) but no significant between-group difference	No effect
Tugault-Lafleur et al. 2023		Virtual	Wearable & Self-Reported	Daily Steps	No between-group difference (mean difference = -137; 95% CI [-901 to 627]; p=.73).	No effect
Wunsch et al. 2024		Virtual	Wearable & Self-Reported	Steps and MVPA	No intervention effect PA outcomes (p>.30).	No effect

RoB 2 Colour Code: yellow = some concerns, red = high risk.
ROBINS-I Colour Code: orange = serious risk, red* = critical risk.*

Types of Rewards Employed (RQ1)

Reward mechanisms identified across the nine included studies were inductively categorised into four types based on their primary motivational characteristics: virtual, social, financial/prize-based, and altruistic incentives.

Virtual rewards were the most prevalent, appearing in seven of the nine studies (Champion et al., 2023; Corepal et al., 2019; Peuters et al., 2024; Schoeppe et al., 2020; Stasinaki et al., 2021; Tugault-Lafleur et al., 2023; Wunsch et al., 2024). These included digital badges, in-game currency (coins, dollars, diamonds), stars, and virtual keys. Virtual currency frequently enabled secondary mechanics such as avatar customisation (Peuters et al., 2024) or unlocking narrative content (Schoeppe et al. 2020; Tugault-Lafleur et al., 2023).

Social rewards, leveraging competitive or recognition-based motivation, appeared in four studies (Champion et al., 2023; Corepal et al., 2019; Schoeppe et al., 2020; Stasinaki et al., 2021).

Financial or prize-based rewards were employed in three studies. Cummings et al. (2022) provided direct cash incentives loaded onto reloadable debit cards for meeting weekly PA goals, totalling up to $510 per participant. Corepal et al. (2019) offered vouchers, goody bags, and a £1000 prize for the winning school. Stasinaki et al. (2021) awarded smartphones to the five most successful participants.

Altruistic rewards were implemented in one study. Duck et al. (2020) introduced Power Points earned through PA, which participants could redeem for UNICEF food packs to be sent to malnourished children in the global south.

Multiple studies combined reward types. Two studies employed both virtual and social rewards (Champion et al., 2023; Schoeppe et al., 2020), whilst Corepal et al. (2019) and Stasinaki et al. (2021) combined all three categories: virtual, social, and financial/prize-based incentives.

Effectiveness of Reward-Based Interventions (RQ2)

Effectiveness findings are presented by reward category, with interpretation weighted by methodological quality. Direction of effect classifications followed predefined criteria (Table 3, 3.1.5).

Virtual Rewards

Seven studies employed virtual rewards, yielding heterogeneous results. Two studies reported positive effects (Peuters et al., 2024; Schoeppe et al., 2020), four reported no effect (Champion et al., 2023; Stasinaki et al., 2021; Tugault-Lafleur et al., 2023; Wunsch et al., 2024), and one provided unclear evidence due to absence of significance testing, which was rationalised for being a feasibility study (Corepal et al., 2019). Critical appraisal reveals substantial limitations. The two positive-effect studies carried critical or serious risk of bias. Schoeppe et al. (2020) lacked a control group

despite reporting substantial increases in active minutes for children (+58 min/day, p<.001) and therefore was assessed with critical risk of bias. Peuters et al. (2024), whilst including a control group, demonstrated serious risk of bias from baseline imbalances and substantial missing objective outcome data. The reported positive effect on PA (X^2=4.36, p=.04) emerged only in subgroup analysis among adolescents with normal sports access during COVID-19 pandemic restrictions, limiting generalisability.

Among the four studies reporting no effect, three were RCTs with some concerns and one with high risk of bias. Champion et al. (2023), the largest trial (n=6640), reported no between-group difference in MVPA at 24-month follow-up (OR=0.82; 95% CI [0.62, 1.09]), with some concerns noted regarding missing data and lack of blinding for self-reported outcomes. Tugault-Lafleur et al. (2023) similarly reported no effect on Fitbit-measured steps at 3 months (mean difference=-137; 95% CI [-901 to 627]; p=.73), with the authors noting potential control group contamination as both groups received Fitbits. Wunsch et al. (2024) found no significant intervention effect for any PA outcome (p>.30) in a sample described as already physically active at baseline. Stasinaki et al. (2021) reported significant improvements in physical capacities for both intervention and control groups after 12 months (p<0.05), with no significant between-group difference. However, the study was considered at high risk of bias due to deviations from the intended intervention and missing outcome data resulting from early dropouts.

The evidence base for virtual rewards is therefore weak. The studies with positive findings carried critical or serious risk of bias, whilst the most methodologically robust studies reported null effects.

<u>Social Rewards</u>

Four studies incorporated social reward mechanisms, though all combined social rewards with virtual incentives, precluding isolation of social reward effects. The results were heterogeneous. Schoeppe et al. (2020), assessed as having a critical risk of bias due to the lack of a control group, reported positive effects. Stasinaki et al. (2021) found no between-group difference despite improvements in both groups. Champion et al. (2023) measured no significant intervention effect. Finally, Corepal et al. (2019) provided unclear evidence, as no significance testing was conducted as measurements remained unchanged.

The limitations identified for virtual rewards apply equally here. Additionally, no study isolated social reward effects from other intervention components.

Financial and Prize-Based Rewards

Three studies employed financial or prize-based incentives. Cummings et al. (2022) provided the only direct financial reward mechanism (cash incentives up to $510) and reported positive effects, though critical risk of bias from the single-arm design prevents causal inference. Corepal et al. (2019) combined financial prizes with virtual and social rewards but provided unclear evidence due to absence of significance testing. Stasinaki et al. (2021) offered smartphones as prizes within a multicomponent intervention but found no between-group difference in physical capacity outcomes, although the high risk of bias from post-randomisation dropouts limits interpretation.

The evidence for financial rewards is insufficient. The single study providing direct monetary incentives lacked a control group, whilst the two studies incorporating prizes as supplementary rewards either did not conduct significance testing or found null effects.

Altruistic Rewards

One study implemented altruistic motivation through redeemable Power Points for charitable food donations (Duck et al., 2020). The study reported no significant between-group difference in MVPA and carried serious risk of bias from non-random participant selection by school principals who were also involved in the study, creating substantial confounding potential. No conclusions can be drawn regarding altruistic reward effectiveness from a single underpowered quasi-experimental study.

Synthesis Across Reward Types

No reward category demonstrated consistent effectiveness across methodologically robust studies. The pattern of findings suggests potential publication bias or selective reporting, as single-arm feasibility studies and quasi-experimental designs yielded positive findings whilst adequately powered randomised controlled trials with lower risk of bias consistently reported null effects.

Several contextual factors may explain heterogeneity in findings beyond reward type. Two studies recruited participants already meeting PA recommendations or described as physically active at baseline (Peuters et al., 2024; Wunsch et al., 2024), potentially creating ceiling effects that limited intervention impact. Conversely, three studies specifically targeted adolescents with overweight or obesity (Cummings et al., 2022; Stasinaki et al., 2021; Tugault-Lafleur et al., 2023), a population that may exhibit different motivational profiles.

A critical characteristic of the evidence base was that all interventions implemented rewards within multi-component mHealth programmes. This design reflects a

pragmatic emphasis on testing real-world applicability rather than isolating reward effects. However, the consistent embedding of rewards within broader interventions prevents causal attribution and substantially limits conclusions regarding the effectiveness of rewards themselves.

4.1.5 Summary of Synthesis

This systematic review identified nine studies investigating reward-based mHealth interventions to promote PA amongst ChAd. The evidence base exhibited considerable heterogeneity in intervention design, target populations, reward types, and outcome measurement, necessitating narrative synthesis rather than meta-analysis.

Four reward categories emerged. Virtual rewards were most common and were delivered through digital badges, in-game currencies, or unlockable content. Social rewards leveraged peer comparison through leaderboards. Financial or prize-based incentives ranged from vouchers to direct monetary payments. Altruistic motivation, employed in one study only, rewarded activity through charitable donations. Several interventions combined multiple reward types. The effectiveness findings revealed an inverse relationship between methodological quality and reported benefits. Studies with critical risk of bias were most likely to report positive effects. Schoeppe et al. (2020) found increases of almost an hour of daily PA without a control group. Cummings et al. (2022) demonstrated improvements with substantial financial incentives but likewise lacked a comparison arm. Peuters et al. (2024) observed benefits only in a pandemic-restricted subgroup with baseline imbalances and substantial missing data. Conversely, the three randomised controlled trials with lower risk of bias found no intervention effects, including the largest with 6,640 participants (Champion et al., 2023). This inverse association between methodological rigour and reported effectiveness suggests that apparent benefits may reflect natural fluctuations towards average activity levels over time (regression to the mean), selective outcome reporting, or publication bias, rather than genuine effects of the interventions themselves.

Drawing firm conclusions is further complicated by multiple factors. Study populations ranged from already active adolescents exceeding baseline recommendations to clinical groups with overweight or obesity. Family-based approaches added complexity through multi-generational participation requirements. Measurement inconsistencies, variation in intervention duration, and extended follow-up periods further limited comparability. Critically, no studies isolated reward effects from other

intervention components through factorial or dismantling designs, nor examined reward schedules, magnitude, or dose-response relationships. None explicitly recruited based on gaming engagement or integrated rewards into established gaming ecosystems. Even the RCTs exhibited methodological concerns including lack of blinding, contamination between control and intervention groups, and incomplete outcome data. Taken together, these limitations constrain confidence in the current evidence base and suggest that the effectiveness of reward-based mHealth interventions for promoting PA among young people remains unproven.

These findings directly inform the business model development objective of this thesis. A critical gap identified across all nine studies is the absence of interventions integrating rewards into the established video-game ecosystems of youth. Instead, interventions relied on standalone applications requiring participants to adopt unfamiliar technologies outside their existing routines. None explicitly recruited based on gaming engagement or tailored reward mechanisms to gaming-specific motivational profiles, despite gaming being a near-universal activity amongst young people (MPFS, 2023, p. 54, 2024, p. 49). The HealthGrind concept addresses this gap by proposing integration of PA rewards directly into established gaming contexts, targeting video-game-playing youth as a specific demographic. The lack of effectiveness in generic reward-based mHealth interventions demonstrated by robust trials raises the assumption that alternative individualised strategies, such as embedding rewards into pre-existing motivational ecosystems, may yield different outcomes.

4.2 Business Model Development

This chapter addresses the second thesis objective: developing a business model blueprint for HealthGrind within the German health market. This objective is justified despite inconclusive effectiveness evidence for three reasons. First, the HealthGrind prototype demonstrated preliminary feasibility (Haghighi Fashi, 2025). Second, gaming-integrated rewards remain empirically untested rather than empirically refuted. Third, understanding business model requirements is necessary for pilot implementation that could generate missing effectiveness evidence.

The analysis comprises two components. Chapter 4.2.1 presents an Environmental Analysis examining external market forces, industry dynamics, regulatory trends, and macroeconomic conditions shaping the German health market for youth mHealth interventions. Chapter 4.2.2 synthesises these findings to propose a Business Model

Canvas defining how HealthGrind could create, deliver, and capture value if effectiveness were demonstrated through future empirical testing.

4.2.1 Environmental Analysis

4.2.1.1 Market Forces

This chapter analyses the key market forces that constitute the external environment for the proposed mHealth intervention. The analysis is structured into four sections. The first, Market Context and Competitive Landscape, identifies the key issues driving and transforming the market by examining the central tensions and structural factors from both customer and provider perspectives. The subsequent section, Primary and Growth Segments, identifies and describes the principal B2C and B2B market segments, evaluating their characteristics and attractiveness to define the target populations for the intervention. The third section, User Needs and Switching Costs, outlines the distinct needs and demands of these segments and analyses the barriers, or switching costs, that influence the adoption of new services. Finally, the Revenue Potential and Willingness to Pay section assesses the financial attractiveness of each segment and the associated pricing power, examining the factors that determine a customer's or partner's willingness and capacity to pay for the intervention.

Market Context and Competitive Landscape

The relevant market is defined by a central tension between the high engagement of ChAd with sedentary video-games and an increasing societal and parental demand for the promotion of PA. A critical structural factor within the gaming sector is that major publisher business strategies have become centered on 'live-service' models. These are games designed for long-term engagement through continuous updates and are primarily monetised through microtransactions. These small, real-money payments allow players to acquire in-game items or advantages instantly, effectively bypassing the need for effort-based progression. The economic dominance of this approach is undeniable. In Germany, revenue from microtransactions is projected to reach €4.5 billion in 2024, significantly surpassing the €921 million generated from direct game sales (Puppe, 2025). Electronic Arts, a global game publisher, reported that live services generated 73% of its total net revenue in fiscal year 2023, a figure that has been increasing annually (Electronic Arts Inc., 2025, p. 74), exemplifying how microtransactions and live-service models have become central to major publisher business strategies. This monetisation strategy creates a potential market conflict for alternative models that seek to reintroduce effort-based progression, or a grind-to-progress framework (defined here as effort-based progression systems requiring sustained activity investment rather than monetary payment), as a non-monetary

pathway to rewards. Simultaneously, parental concerns about excessive screen time and sedentary lifestyles (Chong et al., 2023) create a clear demand for solutions that integrate productively with established gaming habits rather than prohibit them.

Existing precedents in this space include exergames (e.g., Active Video-Games like Nintendo Ring Switch), recognised as interventions to increase PA requiring specific platform acquisition (Baranowski et al., 2012; Sato et al., 2021), and gamified health applications (e.g., the Nike Run Club application), which utilise game elements to promote engagement and brand attitude (Rodrigues et al., 2021). However, a challenge associated with these interventions is the necessity of acquiring extra devices to perform the activity or achieving proper target population design, forcing users to engage with new ecosystems and representing a recognised challenge to user acquisition (Ozdamli & Milrich, 2023). Furthermore, systematic review evidence indicates that standalone reward-based mHealth interventions have not demonstrated effectiveness in promoting youth PA when evaluated through methodologically robust trials. Critically, no identified studies examined rewards integrated directly into established gaming ecosystems that already command youth engagement. This evidence gap suggests that whilst generic reward mechanisms applied through standalone applications have failed to motivate sustained behaviour change, the effectiveness of rewards embedded within pre-existing gaming motivational frameworks remains empirically untested.

Primary and Growth Segments

The primary end-user group comprises ChAd in Germany who actively play video-games. Within this demographic, a fundamental distinction can be made based on players' primary mode of in-game investment. One group of players, who refrain from spending money on in-game items, will be characterised as Grinders, as they earn rewards primarily through effort and time investment (Rehbein et al., 2024). The second group consists of paying players, whose spending follows a power-law distribution, wherein a small minority of players accounts for a disproportionately large share of revenue (Dreier et al., 2017; Lovell, 2011). This paying segment is commonly categorised into three tiers based on expenditure: Whales, a small percentage (10%) of high-spending users; Dolphins (40%), who are mid-tier spenders and Minnows (50%) the largest group of users who make small purchases (Dreier et al., 2017; Lovell, 2011). Crucially, academic research has framed this economic segmentation within a public health context, suggesting a correlation between spending levels and the risk of problematic gaming behaviours (Dreier et al., 2017). This research indicates a hierarchy of risk: Whales can share characteristics with individuals

exhibiting gaming disorder, and Dolphins may be classified as at-risk consumers. Conversely, Minnows and non-paying players, like Grinders, are more likely to represent non-pathological gamers (Dreier et al., 2017).

In the B2C domain, parents and guardians constitute the primary paying customer segment. They act as critical financial gatekeepers who actively monitor and control their children's in-game expenditure. A 2024 European survey by Ipsos for Video Games Europe found that among parents whose ChAd spend money in-game, 73% have an agreement in place to manage spending behaviour (Ipsos, 2024, p. 7). These controls are often explicit, with 63% of these parents either requiring their child to ask for permission before each purchase or operating within predefined spending limits (Ipsos, 2024, p. 8). This high level of parental oversight indicates that the B2C value proposition must not only appeal to the end-user's desire for rewards but must also align directly with the parental need for a controllable and ethically sound alternative to manage in-game monetisation.

The B2B segment, SHIs, represents a significant growth opportunity within the German healthcare market. For the purposes of this analysis, two exemplary legal pathways through which SHIs provide access to digital health interventions have been identified, each creating different structural conditions. The first pathway operates through the standardised prevention market governed by § 20 of the Social Code Book V (SGB V), shaped by the Prevention Guideline (German: Leitfaden Prävention) of the National Association of Statutory Health Insurance Funds (GKV-S). This guideline identifies ChAd as a key target group for health promotion and emphasises digital tool usage for preventive interventions (Hupfeld & Siebeneich, 2024, pp. 18, 138). The second pathway functions through Special Care Contracts (German: Besondere Versorgung) under § 140a SGB V, which enables SHIs to conclude selective contracts directly with healthcare providers for integrated care models that can transcend standard sectoral boundaries (SGB V, 1988, § 140a, Art. 1). Both pathways operate within the overarching Efficiency Principle (German: Wirtschaftlichkeitsgebot) (SGB V, 1988, § 12, Art. 1), which mandates that health insurance services be sufficient, appropriate, and cost-efficient. This principle creates a regulatory environment that favours scalable, digital, evidence-based interventions due to their potential for cost-effectiveness and broad population reach.

Game publishers constitute the second critical B2B segment. While they are not direct paying customers, they function as essential strategic partners whose collaboration is required to supply the in-game rewards that form the core of the user-facing Value

Proposition. Their multifaceted role as suppliers, potential competitors, and strategic partners is analysed in greater detail within the environmental analysis of the Industry Forces (4.2.1.2)

User Needs and Switching Costs

From the perspective of ChAd end-users, the primary driver for engagement with gaming-adjacent services appears to be the acquisition of valued digital goods rather than health outcomes (Chan et al., 2017), though whether this gaming-oriented motivation reliably transfers to effort-based PA contexts remains an empirical question. For younger children, switching costs between activities are minimal due to high parental influence (Choo et al., 2015; Ipsos, 2024, p. 8). Expenditure patterns may influence switching costs, with adolescents who demonstrate high expenditure on digital rewards exhibiting “sunk cost fallacy” behaviour whereby previous financial investments create psychological resistance to abandoning the purchase-based system (Meschik et al., 2024, p. 70), potentially creating barriers to adopting effort-based reward systems. For high-spending users, for whom the financial cost of microtransactions is not a meaningful barrier, the immediate euphoric response from instant reward acquisition is the dominant motivator (Jennewein et al., 2025, p. 24). To attract this user group to effort-based models, exclusive rewards that cannot be purchased could serve as motivational incentives (Rockloff et al., 2020, pp. 24–25). Conversely, users who spend little or no money on digital rewards may find effort-based models more appealing, as these systems provide a non-monetary pathway to acquire valued digital goods. Research supports this appeal, as adolescents demonstrate greater tolerance for effort-based tasks compared to adults when pursuing desired outcomes(Sullivan-Toole et al., 2019), suggesting higher engagement potential with effort-based reward systems.

For B2B customers such as SHIs, switching costs are largely determined by the legal framework. Under § 20 SGB V's standardised prevention market, switching costs are negligible as the framework mandates SHIs financing for all certified interventions (Hupfeld & Siebeneich, 2024, pp. 11–12). Conversely, § 140a SGB V Special Care Contracts may generate higher switching costs due to individual selective contracting (German: Selektivvertrag) arrangements (AOK, 2023).

Revenue Potential and Willingness to Pay

Revenue attractiveness varies across segments. Video-game-playing ChAd demonstrate a clear willingness to spend on in-game items, although they lack substantial independent financial means. Survey data from Europe indicates that 18%

of video-game-playing children are willing to purchase in-game items (Ipsos, 2024, p. 4), whereas German survey findings show a higher proportion at 28% (forsa Politik- und Sozialforschung GmbH, 2019, p. 39).

Parental willingness to pay for child health services is frequently linked to socioeconomic status (SES). As direct expenditure data for youth-focused digital health interventions is limited, participation in organised sports provides a useful, if indirect, measure. Research shows children from higher-SES households are nearly twice as likely to participate in organised sports, which require sustained financial investment (Owen et al., 2022). This pattern suggests higher-SES parents are already willing to fund services supporting their children's health. Consequently, it can be hypothesised that this demographic also possesses a greater capacity to invest in premium digital health interventions.

For SHIs, willingness to pay mechanisms differ fundamentally between the two pathways. Under the § 20 SGB V framework, funding follows a standardised, time-limited course model providing one-time subsidies for discrete interventions designed to empower users to integrate learned preventive behaviours into daily life (Hupfeld & Siebeneich, 2024, pp. 74, 149). This pathway explicitly excludes recurring subscription models and continuous financing (Hupfeld & Siebeneich, 2024, p. 74). Under the § 140a pathway, funding models and the willingness to pay are determined through selective contracting agreements with individual SHIs (AOK, 2023). SHIs are motivated to enter such contracts because they allow the testing of innovative care models, offer members tangible added value, and aim to improve care quality while potentially reducing long-term health costs, provided that the interventions are economically efficient (BARMER, 2024).

For game developers, the viability of partnerships with third-party reward platforms is contingent on a clear value proposition that supports their business model. A primary concern for this segment is the potential for such a partnership to negatively affect player retention or cannibalise existing microtransaction revenue (Débordès et al., 2021). Conversely, a key driver for collaboration is the demonstrated capacity of third-party platforms to enhance user engagement. Examples of such collaborative arrangements are examined in Chapter 4.2.1.2, which demonstrates publisher willingness to support reward distribution mechanisms. Game publishers may also be motivated to participate in mHealth interventions to address documented societal stigma surrounding gaming and health, which includes perceptions of gaming as

harmful and stereotypes of gamers as exhibiting negative behavioural traits (Galanis & King, 2025).

4.2.1.2 Industry Forces

This chapter presents an analysis of the key industry forces that define the strategic context for a novel mHealth intervention. The analysis begins with an examination of incumbent Competitors, evaluating the business models, value propositions, and limitations of existing applications in the target market. This is followed by an assessment of potential New Entrants and Insurgent Threats from adjacent markets, specifically global sport brands and game publishers, which possess distinct strategic advantages. Subsequently, the chapter evaluates the power of critical Suppliers and other Value Chain Actors, including platform owners who act as gatekeepers and game publishers who control the supply of rewards. The chapter concludes with an analysis of key Stakeholders, encompassing both the institutional entities governing the German healthcare market and the non-institutional groups, such as parents, who influence public perception and market adoption.

Competitor Analysis

A structured scan of the German Health & Fitness App Store was conducted to identify direct competitors within the mobile health ecosystem that employ incentive mechanisms for PA through tangible financial rewards. Among the 100 most downloaded applications in this category, only two, Macadam (Rank #40) and WeWard (Rank #67), met the eligibility criteria, positioning them as the only identified incumbents within this market niche.

Both applications operate on a multi-sided platform model, creating value by facilitating interactions between two distinct stakeholder groups: individual users and business partners such as retailers and advertisers. For consumers, the value proposition relies on a straightforward mechanism: daily steps are tracked and converted into virtual currency, which can be redeemed for rewards such as gift vouchers, cash equivalents or charitable donations. On the business side, value is generated through the integration of brand partners via sponsored content and promotional activities, including in-app surveys, rewarded advertisements, and incentivised offers. The significant market presence of these applications underscores their commercial validation. For instance, WeWard reports 20 million global downloads and partnerships with major consumer brands (WeWard, 2025a), indicating substantial reach and established brand awareness.

These incumbents utilise a freemium monetisation strategy that segments users into two tiers: a non-paying majority with access to core features, and a paying minority who subscribe for enhanced capabilities (Numminen et al., 2022). Since neither application discloses detailed financial statements, monetisation mechanisms must be inferred from observable features. The prevalence of advertisement-based reward systems, such as incentivised video ads and survey completions, strongly suggests that advertising fees represent a primary revenue source (Google LLC., 2025b). Moreover, the integration of retail vouchers as redeemable rewards indicates the likelihood of partner commissions, whereby consumer brands pay for visibility and conversions facilitated through the application (Capponi & Corrocher, 2022).

In terms of competitive positioning, both applications benefit from an extensive user base and a reward structure designed for mass-market scalability. However, these strengths are counterbalanced by notable limitations. Their value propositions remain generalised, and the rewards offered, which are primarily small monetary gains or vouchers, might lack contextual relevance for users with specialised motivational profiles (Huang et al., 2024).

An analysis of the reward mechanics for PA reveals the time investment required to earn monetary incentives on both platforms. To contextualize their earning structures, the WHO recommendation of approximately 12,000 steps for adolescents can be used as a benchmark (Tudor-Locke et al., 2011). At this activity level, WeWard awards 15 'Wards' for 12,000 steps, meaning a user would require 100 days to accumulate the 1,500 Wards necessary for a €5 reward. Macadam awards 125 'Coins' for a comparable 12,500-step threshold, which equates to a duration of 120 days to accumulate the 15,000 Coins required for the same €5 reward. These calculations presume the user relies solely on walking and does not engage with supplementary earning opportunities (see Table 9).

Table 9 - Macadam and WeWard Steps Coins to Reward Ratio

Steps	Macadam Coins	WeWard Coins	Macadam Days to earn €5	WeWard Days to earn €5
2,500	15	3	1000 Days	500 Days
5,000	50	5	300 Days	300 Days
7,500	65	-	231 Days	-
10,000	75	10	200 Days	150 Days
12,500	125	-	120 Days	-
15,000	135	15	112 Days	100 Days

Both platforms also offer rewards for completing surveys or viewing advertisements, which provide different rates of return (see Table 10). However, access to these data-driven earning methods is subject to regulatory constraints that specifically impact younger users. Under Article 8 of the General Data Protection Regulation, individuals under 16 require parental consent for data processing activities such as surveys (GDPR, 2018). Neither WeWard nor Macadam implement parental consent mechanisms for survey participation, despite maintaining app store age ratings permitting downloads by minors. Whilst these platforms are accessible to adolescent users in practice, their operational model does not align with GDPR Article 8 parental consent requirements, creating potential regulatory exposure (MACADAM TECHNOLOGIES SL, 2023; WeWard, 2025b).

Table 10 - Macadam and WeWard Survey Coins to Reward Ratio

APP	Survey Spectrum	Time	Reward	Time to earn €5 (in hours)
WeWard	Lowest Observed	6 Minute	34 Wards	4.4 hours
	Highest Observed	20 Minute	180 Wards	2.8 hours
Macadam	Lowest Observed	6 Minute	132 Coins	4.3 hours
	Highest Observed	22 Minute	2300 Coins	2.4 hours

The systematic review presented in Chapter 4.1.4 identified one study employing direct financial incentives (Cummings et al., 2022), which provided substantially larger rewards (up to $510) than the €5 thresholds offered by these platforms after 100-120 days of activity. That study reported positive effects but was assessed as having critical risk of bias due to its single-arm design. No identified studies evaluated whether small-scale financial rewards of this magnitude can motivate sustained PA in youth populations.

New Entrants and Insurgent Threats

Within the framework of industry analysis, potential long-term competitive threats extend beyond existing mHealth applications to include new entrants or insurgents, from two adjacent markets: global sport brands and incumbent game publishers. Each category presents a structurally different competitive challenge based on its unique assets and market position.

First, global sport brands such as Nike and Adidas possess several competitive advantages that position them as potential entrants. They have significant brand credibility and trust in the domain of PA, a key asset for gaining acceptance from parents and adolescent users (Eyada, 2020). Furthermore, they operate established

digital ecosystems through their own widely used fitness applications (e.g., Nike Run Club, Adidas Running), providing a ready-made platform and a large user base already familiar with virtual reward systems such as achievement badges (Rodrigues et al., 2021). Crucially, they have also collaborated on branded in-game content, for example Nike with Fortnite (Epic Games, Inc., 2021, 2024) and Adidas with Roblox (adidas AG, 2023). These partnerships provide them with significant strategic leverage. They represent a pathway to the gaming audience that could be adapted to integrate activity-based rewards, thereby lowering an important barrier to market entry should the companies choose to pursue such a strategy.

A second, structurally different threat comes from the game publishers themselves. Their primary competitive advantage lies in the potential for seamless vertical integration, absorbing the core value proposition of an effort-based reward system directly into their own ecosystems. The viability of such a strategic move is not merely theoretical. In 2020, Electronic Arts explored this model for its mobile EA Sports FC title through a collaboration with Adidas that utilised a digitised shoe sole to link real-life football behaviour with in-game rewards (Petzold, 2020). Whilst this service is no longer accessible, its past implementation confirms that major publishers have previously experimented with activity-to-reward mechanisms. The discontinuation indicates that substantial barriers were encountered, though the specific reasons remain undisclosed. Despite this precedent of market exit, PA-to-reward mechanisms could plausibly be integrated into established gaming frameworks. Epic Games provides a relevant case. Its Fortnite ecosystem functions as a live-service model that generates revenue through optional in-game purchases (Meschik et al., 2024, pp. 4, 18). Central to this model is the Battle Pass system, which combines grinding mechanics with microtransactions. Players must first buy access to a Battle Pass and then invest time playing the game or completing quest-related tasks to unlock exclusive rewards and thereby amortise their initial purchase (Meschik et al., 2024, p. 248). Incorporating PA tasks as an additional pathway to these rewards would represent a logical feature extension and would align with the established presence of sport-related brands in the game. However, game publishers face several key barriers to entry, including the technical complexity of health data integration as well as regulatory requirements (described in the Regulatory Trends section within 4.2.1.3). Finally, this approach carries the risk of cannibalising established microtransaction revenue streams (Débordès et al., 2021). For example, if PA were to replace some portion of the screen time currently required to progress through a

Battle Pass, this could lower engagement levels that often drive microtransaction purchases.

Suppliers and Other Value Chain Actors

The relevant value chain is composed of several powerful, incumbent players from the technology, gaming, and health sectors. The most critical suppliers are the operating system and health data platform providers, namely Apple (iOS, HealthKit) and Google (Android, Google Fit). These entities function as essential gatekeepers, controlling not only the distribution of any application via their respective app stores but also access to the underlying health data through their APIs, which is necessary for such a service to function (Apple Inc., 2025c; Google LLC., 2025c). The ability for any venture in this space to operate is therefore contingent upon ongoing compliance with the technical and policy requirements set by these platform owners.

A second critical set of suppliers are the game publishers, such as Electronic Arts. As the creators of the digital environments in which rewards hold value, they control both the content and the technical infrastructure that determine how in-game goods can be issued (Electronic Arts Inc., 2025, pp. 81–82). Because only the publishers can authorise external access to these systems, partnerships or an open API framework are prerequisites for any third-party initiative that seeks to distribute legitimate in-game rewards. One prominent example of such third-party initiatives is the use of live-streaming platforms, which can interface with publishers' APIs to deliver rewards to users. On Twitch.tv, a live-streaming platform dedicated to video gaming, many game publishers run 'Twitch Drops' campaigns (Twitch Interactive Inc., 2025). In these campaigns, viewers who meet specified criteria, such as watching a particular game stream for a set amount of time, receive exclusive in-game rewards. This practice demonstrates two key technical precedents. First, it confirms the feasibility of authorised API connections enabling third-party platforms to deliver in-game rewards. Second, it demonstrates publishers' structural willingness to grant rewards through external platforms when aligned with marketing objectives. This precedent indicates that publishers may collaborate with external services that can demonstrably increase attention to their games.

Wearable device manufacturers (e.g., Fitbit, Garmin, Apple Watch, Google Watch, Samsung Watch) are an important component of the value chain, as their devices provide relevant source of PA data. Evidence indicates that, for long-term step tracking, wearable devices record an average of 30% more steps than smartphone applications, likely due to their continuous wear on the body, whereas smartphones

are frequently not carried during daily activities (Piccinini et al., 2020). This difference highlights the potential of wearable devices to provide more complete data streams for applications that rely on accurate activity monitoring.

Stakeholders

Key stakeholders in the B2B market include the GKV-S, which establishes certification requirements through the Prevention Guideline and the Central Testing Centre for Prevention (German: Zentrale Prüfstelle Prävention, ZPP), which evaluates prevention offers under § 20 and determines whether they meet these requirements (Hupfeld & Siebeneich, 2024, p. 75). SHI are obligated to subsidise only those interventions that the ZPP certifies as compliant (Hupfeld & Siebeneich, 2024, pp. 11, 13). Under the § 140a framework, individual SHIs are the stakeholders authorised to conclude contracts directly with providers of digital services and applications, enabling bilateral contracting arrangements (SGB V, 1988, § 140a, Art. 3(8)).

Parents and advocacy groups represent another critical stakeholder group. Their influence is dual-faceted: they are a primary customer segment in the B2C model and a powerful external force shaping public opinion and regulatory scrutiny. Concerns regarding children's screen time, data privacy and the potential for manipulative design in applications targeting youth can significantly impact market acceptance and the willingness of parents to adopt the service (Bhutani et al., 2025).

Healthcare and Educational Professionals represent a crucial stakeholder group that provides the clinical credibility and pedagogical expertise essential for intervention legitimacy. This includes physiotherapists who ensure age-appropriate PA design, psychologists who validate behavioural intervention components, and pedagogues who contribute developmental expertise for age-specific engagement strategies. These professionals serve a dual function. First, they lend credibility that satisfies parental trust expectations, as evidence suggests that consumers' trust in healthcare professionals can be transferred to endorsed digital health services (Catapan et al., 2025). Second, their involvement aligns with WHO guidance on youth-centred digital health interventions, which emphasises the importance of including healthcare professionals and content-area experts in intervention development to ensure quality and safety (WHO, 2020b, p. 14). Their involvement is particularly critical given that individualised PA programmes demonstrate significantly higher efficacy rates compared to standardised approaches (Baumann et al., 2022).

4.2.1.3 Key Trends

The analysis first covers key Technological Trends within relevant health applications. It proceeds to examine the Sociocultural Trends that drive user behaviour in digital environments, as well as the Socioeconomic Trends that influence digital expenditure. Finally, the analysis outlines the formative Regulatory Trends which define the legal and ethical boundaries for services targeting minors.

Technological Trends

The advancement of generative artificial intelligence (AI) represents a pivotal technological trend with implications for digital health. A recent scoping review by Gabarron et al. (2024) systematically analysed this trend, identifying that the primary function of AI in current mHealth applications is to deliver personalised and adaptive interventions. The review found that these systems, most commonly recommender systems, analyse user data to adapt interventions to an individual's physical capacity and personal preferences, with the objective of proposing "challenging, achievable, and tailored goals" (Gabarron et al., 2024, p. 5). However, the authors' analysis of the existing literature concluded that the evidence for AI's effectiveness in changing PA behaviour is of very low certainty, and the evidence for increasing PA outcomes (e.g., step counts) is of moderate certainty (Gabarron et al., 2024). This pattern of limited evidence for novel technological approaches aligns with the systematic review findings (4.1.4), which demonstrated that reward-based mHealth interventions have not proven effective in methodologically robust trials, suggesting that technological innovation alone may be insufficient without validated behavioural mechanisms.

A second identified technological trend is the use of map- and location-based gamification to incentivise real-world movement. The applications identified within the competitor analysis (Macadam and WeWard) both employ this gamification feature, which was popularised by the augmented reality game Pokémon GO (Niantic, Inc., 2025). The commercial adoption of location-based mechanics by multiple platforms indicates market validation. Empirical evidence from Pokémon GO demonstrates that location-based mechanics can effectively increase PA (Althoff et al., 2016), establishing this as both a commercialised and evidence-supported technological approach.

Sociocultural Trends

A primary sociocultural trend is the normalisation of in-game spending, which has established a clear willingness among ChAd to pay for virtual goods (Jennewein et al., 2025, p. 4; Meschik et al., 2024, p. 43). This expenditure is not indiscriminate but

is driven by the significant perceived value of digital items. Qualitative research indicates that these items serve complex functions beyond simple aesthetics as they provide social status, enhance the gameplay experience, facilitate social interaction and can be a source of excitement and emotional regulation (Nicklin et al., 2021). The pursuit of these digital goods is a powerful motivational force, establishing a clear behavioural precedent that in-game rewards are valuable and worth attaining (Jennewein et al., 2025, p. 17; Meschik et al., 2024, p. 51).

A second societal trend is the temporal and developmental increase in gaming engagement among German youth. Population-level data indicate that average weekly gaming time among male ChAd increased from 1 hour and 47 minutes in 2012 to 3 hours and 18 minutes in 2022 (Destatis, 2025b). Contemporary age-stratified data for female and male ChAd reveal substantial variation across developmental stages: daily gaming time on PC, laptop, tablet, or console averages 17 minutes among 6-7 year-olds, rising to 42 minutes among 12-13 year-olds (MPFS, 2023, p. 73), and reaching 103 minutes among 14-15 year-olds before stabilising at 83-101 minutes through late adolescence (MPFS, 2024, p. 50). This pattern demonstrates both a long-term societal shift toward increased gaming engagement and an age-dependent intensification during the transition from childhood to adolescence.

Socioeconomic Trends

Gaming engagement patterns demonstrate clear socioeconomic stratification. Among adolescents aged 12-19 years, 80% of Haupt-/Realschule students play digital games regularly compared to 69% of Gymnasium students, with daily gaming duration averaging 110 minutes versus 73 minutes respectively (MPFS, 2024, p. 50). This pattern extends to younger children, where parental educational background correlates with screen time, with children of parents with formally low educational backgrounds averaging 198 minutes daily compared to 171 minutes among those with highly educated parents (MPFS, 2023, p. 73). Combined with the finding that lower-educated adolescents are more likely to spend on in-game items (38% versus 24%) (forsa Politik- und Sozialforschung GmbH, 2019, pp. 37, 40), this pattern indicates that lower-SES youth demonstrate both higher gaming engagement and higher expenditure on digital goods, despite possessing fewer economic resources.

Regulatory Trends

The digital health landscape in the European Union is defined by a robust and evolving regulatory framework. For any digital health intervention that targets minors and processes health-related data, these regulations are not merely compliance

hurdles but are formative forces that shape potential business models, user experience, and strategic positioning. By proactively embedding the principles of the GDPR, the Digital Services Act (DSA), and the emerging European Health Data Space (EHDS) into its core design, a venture can leverage regulatory compliance as a key competitive advantage.

General Data Protection Regulation (GDPR)

The foundational regulatory framework governing the operation of any digital service in the European Union is the GDPR's Regulation 2016/679 (GDPR, 2018). For a venture that processes "data concerning health", it is subject to the GDPR's strictest requirements for handling special categories of personal data (GDPR, 2018, Art. 9 (1), p. 38). First, the regulation imposes stringent conditions for data processing, especially concerning this target demographic. The processing of personal data of a child below the age of 16 years is only lawful if consent is given or authorised by the holder of parental responsibility over the child (GDPR, 2018, Art. 8 (1), p. 37). Furthermore, the principle of "data protection by design and by default" (GDPR, 2018, Art. 25 (1), p. 48) requires that the highest level of privacy protection is integrated into the service from the outset.

Digital Services Act (DSA)

Building on these foundational data principles, the European Union's DSA (Regulation (EU) 2022/2065) introduces further obligations for any venture that functions as an "online platform" (DSA, 2024, Art. 3 (i), p. 43). The regulation imposes a high standard of care for platforms accessible to minors. The DSA mandates that platforms must implement "appropriate and proportionate measures to ensure a high level of privacy, safety, and security of minors" (DSA, 2024, Art. 28, p. 60). This is reinforced by a strict prohibition on presenting advertisements based on profiling using the personal data of a recipient when the provider is "aware with reasonable certainty that the recipient of the service is a minor" (DSA, 2024, Art. 28 (2), p. 60). This rule is further compounded by the general ban on profiling based on health data (DSA, 2024, Art. 26 (3), p. 59). Second, the commitment to ethical design is further reinforced by the DSA's prohibition of dark patterns interfaces designed to "deceive or manipulate" users or compromise their capacity for autonomous and well-informed choices (DSA, 2024, 25 (1), p. 58). This regulation has direct relevance to the monetisation models prevalent in the modern gaming industry. Many free-to-play and live-service games employ interface designs and psychological cues that can be interpreted as manipulative, specifically to drive in-game purchases and microtransactions (Petrovskaya & Zendle, 2022).

European Health Data Space (EHDS)

A key regulatory trend shaping the future market for digital health is the EHDS, a framework designed to encourage the secure exchange and secondary use of electronic health data across the EU (EHDS, 2025). Within this framework, ventures processing electronic health data for purposes other than the direct provision of healthcare would typically fall under the category of a “wellness application” (EHDS, 2025, Art. 2 (2(g)), p. 32). The regulation mandates that any wellness application claiming interoperability with official electronic health record systems must carry an EU-wide label. This label serves as a visible, verifiable mark of quality, confirming that the application complies with the EU's essential requirements for interoperability, security, and data protection (EHDS, 2025, Art. 49, pp. 56-57). Research highlighting trust as a central determinant of digital-health adoption underscores the importance of external quality-assurance measures (Liu & Tao, 2022). By operating as a wellness application which utilises health data, the operator would be designated as a “health data holder” (EHDS, 2025, Art. 2 (2(t)), p. 33). This entails a future legal obligation to make collected, pseudonymised user data available for secondary use, such as public health research, upon request from a designated national "health data access body" (EHDS, 2025, Art. 60, pp. 64-65). However, this requirement does not apply to all operators, as microenterprises are exempt from this rule (EHDS, 2025, Art. 50 (1), p. 57).

The Legal Framework for Digital Prevention & Special Care in Germany

Digital prevention offers under § 20 SGB V require formal certification through criteria established by the GKV Prevention Guideline (SGB V, 1988, § 20, Art. 2) by the ZPP. The core requirement is scientific evidence of health benefit through a prospective, single-group, pre-post study design with pre-registration and measurements at baseline, six weeks post-intervention and three to six months follow-up (GKV, 2024, p. 5). For movement interventions, studies must demonstrate statistically significant improvements in activity time or reduction of inactivity (GKV, 2024, p. 10). Structural requirements include individual support within 48 hours from professionally qualified personnel holding state-recognised vocational training or university qualifications in relevant health fields (Hupfeld & Siebeneich, 2024, pp. 69, 146). Conceptual standards mandate systematic application of the Behaviour Change Techniques taxonomy developed by Michie et al. (2015), specifically from four categories: Goals and Planning, Feedback and Monitoring, Education, and Repetition and Substitution (GKV, 2024, pp. 8–9). The funding framework imposes strict constraints: interventions must be completed within six months, followed by one year of free access for users

to independently review completed content and reinforce learned behaviours (Hupfeld & Siebeneich, 2024, p. 149). The framework explicitly excludes interventions that are tied to existing or future memberships, designed as permanent offers, or conducted by providers with interests in selling accompanying products (Hupfeld & Siebeneich, 2024, p. 74).

The second legal pathway is provided by Special Care Contracts under § 140a SGB V. This pathway allows individual SHIs to form direct agreements with healthcare providers for novel care models. The core purpose of § 140a is to facilitate integrated care, which enables cross-sectoral or interdisciplinary health services (SGB V, 1988, § 140a, Art. 1). The framework allows contracts to deviate from standard regulations in areas like service provision and remuneration, provided the new model aims to improve the quality, effectiveness, and economic efficiency of care (SGB V, 1988, § 140a, Art. 2). The law permits contracts with a broad spectrum of partners, including providers of digital services and applications such as information technology companies and research institutions (SGB V, 1988, § 140a, Art. 3 (8)). Market access under this pathway requires selective contracting with individual SHIs (AOK, 2023; Bundesgesundheitsministerium, 2025), therefore the financial terms of these contracts are subject to direct negotiation. For the insured, participation is voluntary and requires a declaration, with a mandatory two-week withdrawal right without reason (SGB V, 1988, § 140a, Art. 4). Data processing for the contract's implementation is contingent on the patient's prior informed consent (SGB V, 1988, § 140a, Art. 5).

4.2.1.4 Macro-economic forces

This section provides an analysis of the macroeconomic forces that define the broad economic context for a new venture in Germany. The analysis is structured into four key dimensions that shape the business model's opportunities and constraints. It begins with an examination of the general Market Conditions, including national economic performance and consumer spending trends. Subsequently, it outlines the foundational Economic Infrastructure, encompassing the digital, fiscal, and legal systems that govern a venture's operations. The third part assesses the Capital Markets, focusing on the venture capital landscape and the public support infrastructure for start-ups. The section concludes with an analysis of Commodities and Other Resources, which evaluates the availability and cost of essential human capital in the German labour market.

Market Conditions in Germany

According to the European Commission (2025), Germany is currently in a phase of economic stagnation. After contracting in 2024, real GDP growth is forecast to remain flat at 0.0% in 2025, with only a modest recovery of 1.1% projected for 2026. This lack of growth is largely attributable to structural weaknesses in the export-oriented industrial sector, which continues to face subdued global demand and competitiveness challenges. However, domestic demand has proven comparatively resilient, providing an important stabilising force within the economy (European Commission, 2025). Data from the German Federal Statistical Office (Destatis) (2025a) further underscore this trend. In the first quarter of 2025, household final consumption expenditure rose by a price-adjusted 0.5% compared to the previous quarter. On an annual basis, consumption expenditure increased by 3.2%, surpassing the 2.5% growth in household income. Notably, this upward trajectory included higher spending on health-related goods and services, reflecting sustained consumer prioritisation of health and well-being even in a stagnating macroeconomic environment (Destatis, 2025a). Analysis of the German labour market by the Organisation for Economic Co-operation and Development (OECD) (2025) provides further context on domestic economic conditions. While the unemployment rate is projected to rise to 3.6% by the end of 2025, it remains well below the OECD average. In parallel, real wages grew by 0.4% between the first quarter of 2024 and the first quarter of 2025 (OECD, 2025, p. 1). This indicates that the growth in real wages supports the conditions for sustained private consumption.

Economic Infrastructure

The economic infrastructure of the German market provides the foundational framework upon which the proposed business model must be built. This framework encompasses the digital, fiscal, and legal systems that govern a venture's operation, distribution, and financial viability. A primary component for an application-based model is the digital distribution and payment infrastructure, which is dominated by the operating systems of Google and Apple. Operation within these ecosystems is mandatory for market access and requires adherence to platform-specific policies, such as Apple's (2025b) App Store Review Guidelines. A key structural provision is the compulsory use of proprietary in-app payment systems for all digital transactions. Within the European Union, this results in a structural commission fee of 17% levied by Apple on all purchases and subscriptions (Apple Inc., 2025a). Google applies a similar service fee of 15% (Google LLC., 2025a).

The fiscal and legal infrastructure dictates further operational costs and requirements. All revenue generated in Germany is subject to a Value Added Tax (VAT) of 19% (IHK, 2025a). Ventures operating under the legal structure of a limited liability company (GmbH) are subject to the federal Corporate Income Tax (German: Körperschaftssteuer) at an effective rate of approximately 15% (Bundesministerium der Finanzen, 2025) and a municipal Trade Tax (German: Gewerbesteuer), which in Hamburg amounts to an effective rate of 16.45% (composed of the uniform federal base rate of 3.5% multiplied by the local municipal multiplier of 470%) (IHK, 2024). Beyond these recurring fiscal obligations, the legal framework for corporate formation mandates certain one-time requirements, including a minimum share capital contribution of €25,000 and legally mandated formation costs for notary services and commercial registration (IHK, 2025b). These initial and recurring costs represent fundamental components of the economic infrastructure within which any such business must operate. On a €10 subscription, a 17% platform fee leaves €8.30 to the merchant. This amount still includes VAT, so after remitting €1.33 VAT, the merchant retains €6.97 net before corporate tax. In effect, platform fees and VAT together absorb about 30% of the gross payment, before any operational costs. Finally, the German economic environment includes a public support infrastructure for new ventures by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) (BMWK, 2022). The federal government has established several strategic initiatives and funding instruments designed to de-risk early-stage investment and promote the growth of technology-oriented start-ups. A detailed analysis of these specific funding instruments will be provided at the end of the subsequent Capital Markets section, as they are integral to the financing landscape.

Capital Markets

According to the Credit Institute for Reconstruction (German: Kreditanstalt für Wiederaufbau, KfW), the German venture capital (VC) market during the first half of 2025 demonstrated contradictory trends, characterised by sustained investment activity alongside deteriorating investor confidence. Following strong performance in the second quarter, total investment volume reached approximately EUR 4 billion for the first half of 2025, representing the third consecutive six-month period of market expansion (Viete & Metzger, 2025, p. 3). Second quarter investment totalled EUR 2.4 billion, reflecting a 45% increase from the preceding quarter (Viete & Metzger, 2025, p. 3). This positive trajectory, however, contrasts sharply with a marked decline in market sentiment. The VC sentiment indicator decreased substantially during the second quarter of 2025, primarily attributed to increased uncertainty surrounding

global political developments, including US trade policy and geopolitical tensions (Viete & Metzger, 2025, p. 1). Despite these adverse conditions, capital allocation across sectors remains heterogeneous, with certain industries demonstrating comparative resilience. The health sector is particularly notable, consistently representing the largest proportion of financing transactions. During the second quarter of 2025, the sector accounted for 13% of all transactions, compared to an annual average of 15% in the preceding year, indicating sustained investor interest (Viete & Metzger, 2025, p. 7). Early-stage financing remains a substantial component of the German funding landscape, with EUR 222 million invested in seed-phase transactions during the second quarter of 2025 (Viete & Metzger, 2025, p. 14). However, valuation concerns have intensified, as investors increasingly regard start-up valuations as excessive, a trend reflected in the sharp decline of the valuation sentiment indicator during the second quarter of 2025 (Metzger, 2025, p. 2).

While KfW reports document current market activity and investor sentiment, analyses by the Leibniz Centre for European Economic Research by Berger et al. (2020) provide a complementary perspective by examining financing patterns across founding cohorts. Their findings indicate that, despite the visibility of VC funds, they have not been the predominant source of early-stage financing in earlier cohorts of start-ups. Between 2015 and 2018, VC funds provided financing to only 0.9% of young companies, whilst private investors supported 7.5% (Berger et al., 2020, p. 7). This disparity translates into substantially larger aggregate volumes: private sources provided an annual average of €2.78 billion, exceeding the €613 million contributed by VC funds by more than four-fold (Berger et al., 2020, p. 50). The significance of private investors has increased markedly in innovation-driven sectors, evidenced by the near-doubling of the proportion of young firms receiving such funding between the 2009–2012 and 2015-2018 cohorts (Berger et al., 2020, p. 5). Among these private investors, business angels represent a particularly vital subgroup. Their contribution often extends beyond financial resources, as a majority (73%) operate as active partners, providing strategic advice and facilitating access to networks of customers and financiers (Berger et al., 2020, p. 12). Professional business angels dominate the high-tech segment, characterised by larger average deal sizes compared to informal investor networks such as "Family & Friends" (Berger et al., 2020, p. 24). The relevance of private investors is further reinforced by public policy instruments aimed at mobilising private capital. The INVEST grant constitutes a central mechanism in this regard. Among high-tech firms receiving eligible financing, nearly 50% benefit

from an INVEST-backed investor, which correlates with significantly higher investment sums (Berger et al., 2020, pp. 36, 38).

In response to these financing challenges, the BMWK (2022) initiated its Start-up Strategy in 2022, which seeks to address structural weaknesses in the financing landscape. The strategy combines direct financial interventions with regulatory modernisation to enhance the overall attractiveness of the German capital market. A central component is the Future Fund (German: Zukunftsfond), which, in collaboration with the KfW, will provide ten billion euros in public funds by 2030. This initiative aims to mobilise up to thirty billion euros in total capital to support technology-oriented start-ups. The fund is structured into several distinct modules designed to address specific financing gaps across the entire start-up lifecycle. These modules provide various forms of capital, including equity, venture debt, and fund-of-funds investments, thereby supporting companies from their early growth phases through to late-stage scaling (BMWK, 2022, pp. 7–8). To complement these financial instruments, support for the creation of research-based start-ups from academia continues through the ‘Start-up Founding from Science’ (German: Existenzgründungen aus der Wissenschaft, EXIST) programme, which facilitates the transition from scientific research into commercial ventures (BMWK, 2022, p. 15). Complementing this, the government will re-launch the INVEST programme to stimulate private, early-stage investment from business angels, thereby strengthening a critical source of initial capital for new companies (BMWK, 2022, p. 9).

Beyond direct funding, the strategy addresses structural market conditions. The planned Future Financing Act (German: Zukunftsfinanzierungsgesetz), for instance, is intended to facilitate initial public offerings. The strategy document emphasises the importance of this measure, stating that the prospect of a viable exit through a public listing plays a decisive role in the availability of VC, as a clear path to exit constitutes a key consideration for investors before they commit to funding a start-up in its early stages (BMWK, 2022, p. 6). By simplifying the path to the stock market, the act aims to increase investor confidence and, consequently, the total capital available to new ventures. Furthermore, the strategy aims to strengthen the supply side of the capital market itself. It will expand the value-added tax exemption for VC funds to improve Germany's standing as a fund location (BMWK, 2022, p. 9).

To further improve accessibility and transparency, the government will establish a central digital funding portal to provide user-friendly access for start-ups to find and apply for relevant grants (BMWK, 2022, p. 13). This portal has since been realised as

the 'Förderdatenbank' (BMWK, 2025a). Additionally, the BMWK has developed a taxonomy to classify primary investment instruments according to the developmental stages of a start-up's lifecycle (Figure 4).

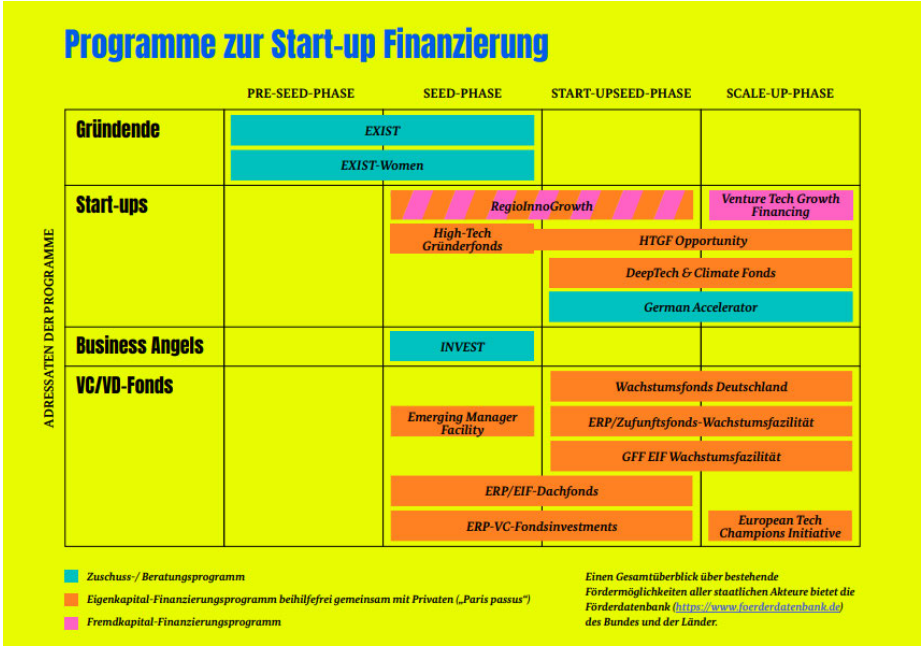

Figure 3 - Demonstrating a funding landscape in Germany by the BMWK (BMWK, 2025b)

Commodities and Other Resources

An analysis of the German labour market in August 2025 by the Federal Employment Agency (German: Bundesagentur für Arbeit, BfA) reveals a complex environment that influences the availability and cost of essential human resources. The broader economy is experiencing a period of stagnation, reflected in a 0.3% gross domestic product contraction in the second quarter of 2025 (BfA, 2025b, p. 6; Hutter & Weber, 2025). This economic caution is reflected in corporate hiring behaviour, creating a market where the chances for an unemployed individual to secure new employment are at a historically low level (BfA, 2025b, pp. 12, 14). Whilst the risk of job loss for currently employed individuals remains comparatively low, it is steadily increasing, further influencing the recruitment landscape (BfA, 2025b, p. 15). However, according to an assessment by the Institute for Employment Research, following a prolonged difficult period, the labour market is showing initial positive signals of stabilisation (Hutter & Weber, 2025). In August 2025, seasonally adjusted unemployment fell for the first time after a three-year period of increases, and the decline in the number of reported job vacancies slowed to a slight decrease (Hutter & Weber, 2025). Despite these signs of stabilisation, the ease of obtaining talent is highly dependent on the profession. Whilst the BfA reports that there is no general shortage of skilled labour, significant bottlenecks exist for specific professions, most notably in IT, various

medical and care professions, and education since 2024 (BfA, 2025a, p. 5, 2025b, p. 11). The analysis of skilled labour shortages or bottleneck occupations (German: Fachkräfteengpassanalyse) by the BfA (BfA, 2024c) offers a more nuanced view. It investigates bottleneck occupations by classifying professions according to a composite index, where a shortage is identified by a score between 2 ('weak signs') and 3 ('signs'). Additionally, the analysis further categorises labour by level of educational requirements, focusing not only on skilled labour (e.g., vocational training level) but also specialists (e.g., bachelor's level) and experts (e.g., master's level) (BfA, 2010). An in-depth analysis of the BfA bottleneck-occupation database (BfA, 2024a) identified relevant professions in Technology & Design, Health & Pedagogy, and Business & Management, together with their composite indices, corresponding educational-requirement levels, and reported salaries from the BfA's Salary Atlas (BfA, 2024b). For professions relevant to technology, health, and business, the analysis reveals the following specific bottlenecks and salary structures (see Table 11). A bottleneck was identified for experts in software development (index score: 2.2) and for specialists in media informatics (index score: 2.0). A significant bottleneck was also reported for specialists in physiotherapy (index score: 2.7). No bottlenecks (index score < 2.0) were identified for professions in graphic design, business informatics, non-clinical psychology, social pedagogy, business administration, or economics.

Median gross monthly salaries varied considerably across the analysed professions. For experts, the reported median salary was highest in general informatics (€6,478) and software development (€6,097). For specialists, the highest median salary was reported in business informatics (€6,321), while the lowest was in physiotherapy (€3,248).

Table 11 - BfA Bottleneck-Analysis findings and associated salaries

Profession Name	Skilled	Specialist	Experts	Salary (Median Gross Monthly)
Technology and Design				
Graphic, Communication, & Photo Design (2322)	0.8	1.2	1.0	Expert: 3770 €
Computer Science (4310)	1.2	1.5	1.7	Expert: 6478 €
Business Informatics (4311)	1.2	1.3	1.5	Special: 6321 €
Media Informatics (4315)	-	**2.0**	1.0	Expert: 4876 €
Software Development (4341)	1.2	1.8	**2.2**	Expert: 6097 €

Health & Pedagogy				
Non-Clinical Psychology (8161)	-	-	1.4	Expert: 5102 €
Physiotherapy (8171)	1.8	**2.7**	-	Special: 3248 €
Social Pedagogy (8312)	-	1.0	1.6	Expert: 3737 € (Sports Pedagogue)
Business & Management				
Commercial Business Administration (7130)	1.5	1.5	1.6	Special: 5687
Economic Sciences (9148)	-	-	1.3	Expert: 5613 €

Adapted from the BfA (2024a) bottleneck analysis. An index score of 2.0 or higher signifies a skilled labour bottleneck (bold).

These salary figures represent median values aggregated across all experience levels within each profession. The BfA data do not provide experience-stratified salary information. Consequently, whether entry-level positions command lower absolute compensation than these medians, or whether bottleneck occupations maintain wage premiums at entry level relative to non-bottleneck professions, cannot be determined from the available data.

4.2.2 Synthesis of Environmental Analysis

The following synthesis translates environmental analysis into strategic implications for the HealthGrind business model. These implications assume that gaming-integrated reward mechanisms can motivate PA in ways that standalone reward-based interventions have not demonstrated (4.1.5). This assumption requires empirical validation through pilot implementation. The business model development therefore proceeds as hypothesis-driven strategic positioning rather than evidence-confirmed market entry.

4.2.2.1 Synthesis of Market Forces

The analysis of market forces reveals a structural paradox that constitutes the central opportunity for the HealthGrind concept: the concurrent high engagement of adolescents in monetised, sedentary gaming ecosystems and an unmet demand from parents and public health stakeholders for interventions that promote PA. The primary implication is that the business model's strategic function necessitates resolving this conflict. Rather than positioning itself as a competitor to gaming, HealthGrind would need to operate as a complementary service that bridges these divergent interests. The viability of this approach depends on demonstrating to publishers that gaming-

integrated PA rewards can enhance rather than diminish player engagement, though no precedent for such partnerships currently exists in the youth health intervention market. This indicates a value proposition built on integration with, rather than displacement of, users' established leisure habits, thereby reducing switching costs and creating a seamless path to adoption.

The analysis further demonstrates that the target population is not monolithic, requiring distinct value propositions for separate end-user and customer groups. The ChAd end-user segment is itself stratified by spending behaviour. This segmentation suggests prioritising non-paying Grinders and low-spending Minnows as the initial target, as the effort-based model directly addresses their financial barriers to in-game progression. Conversely, high-spending segments retained by instant monetised gratification present higher switching costs and therefore constitute a secondary strategic priority. At the same time, because this group is also associated with heightened risk of problematic gaming, the model can be conceptualised as an ethical and health-promoting alternative that appeals directly to parental concerns in the B2C context. By replacing instant gratification with an effort-based reward structure, the intervention seeks not to exploit vulnerabilities but to redirect gaming motivations towards PA, with the requirement of sustained effort hypothetically functioning as a harm-reduction mechanism relative to microtransaction-based models, though this theoretical benefit requires empirical validation.

For the B2C customer segment, the identified correlation between parental socioeconomic status and willingness to pay for health-promoting activities implies a tiered pricing strategy. A premium subscription could target higher-SES households, whilst a basic or freemium model would ensure accessibility for lower-SES households and non-paying/low-spending user segments.

The analysis of B2B market forces indicates that SHIs can finance digital health interventions through at least two distinct approaches. This structure presents a strategic choice between two fundamentally different market entry pathways. The first pathway, the standardised prevention market under § 20 SGB V, offers a broad, scalable opportunity where a single certification makes an intervention eligible for subsidies from all SHIs nationwide. However, this pathway operates under a rigid, time-limited funding model that prohibits recurring revenue streams. The second pathway, via Special Care Contracts under § 140a SGB V, provides a more flexible, decentralised market where individualised contracts can be negotiated directly with individual insurers. This route allows for innovative models and potentially sustainable

financing but limits market access to a single contracting partner at a time. The core implication is that viable business model architecture requires either conforming to the strict standardisation of § 20 to achieve scale or leveraging the flexibility of § 140a to pursue a more tailored, partnership-based approach.

Finally, the model's long-term sustainability depends on securing strategic partnerships with game publishers to ensure a supply of appealing in-game rewards. Given that publishers' business models are increasingly dependent on microtransaction revenue, successful collaborative frameworks would need to address concerns about revenue impact. Viable partnerships therefore require demonstrating that the intervention does not reduce player engagement or retention. This value proposition can be strengthened by framing the collaboration as a Corporate Social Responsibility initiative, offering publishers a tangible mechanism to strengthen their public image and counter the stigma associated with sedentary gaming among parents and regulators.

4.2.2.2 Synthesis of Industry Forces

The preceding analysis reveals a significant market gap for a specialised intervention. As demonstrated, incumbent competitors rely on data-driven earning methods that, due to GDPR constraints, are regulatorily misaligned with the youth demographic. This misalignment, combined with unvalidated reward magnitudes (systematic review findings identified no empirical evidence supporting the effectiveness of small-scale financial incentives comparable to incumbent platforms for youth populations), presents an opportunity for HealthGrind to develop an ethically responsible model employing gaming-integrated rewards with demonstrated contextual relevance to the target demographic.

The market opportunity is, however, defined by a critical long-term threat from new entrants. Electronic Arts' discontinued collaboration with Adidas demonstrates that publishers have explored activity-to-reward models but encountered unresolved barriers, whether technical, commercial, or regulatory. Whilst global sport brands possess brand credibility and digital ecosystems to enter the market, the more structural threat is considered by the game publishers themselves, who could vertically integrate the intervention's core features into their own ecosystems. This threat, combined with the power of essential suppliers such as platform owners (Apple, Google) and the publishers who control the supply of rewards, dictates that a standalone, competitive business model faces substantial structural barriers. Consequently, the business model's long-term sustainability is contingent upon a

collaborative and integrated strategy. The intervention would require positioning as a specialised partner that manages the technical and regulatory complexities of health data whilst providing analytics on reward efficacy. Precedents such as Twitch Drops demonstrate publishers' willingness to distribute rewards through third-party platforms when aligned with marketing objectives. However, whilst PA may displace other leisure activities rather than gaming time, publishers would require assurance that player engagement is not negatively affected, necessitating a value proposition distinct from passive engagement models. HealthGrind would therefore need to articulate promotional benefits that justify this structural difference, potentially positioning itself as a complementary channel that enhances brand reputation and addresses regulatory concerns regarding sedentary gaming, rather than directly increasing concurrent player metrics. Whether gaming-integrated rewards can overcome the barriers encountered in prior attempts and the null findings from generic reward mechanisms remains an empirical question requiring pilot validation.

The partnership-centric approach would also need to navigate the two identified roles of SHIs as primary B2B stakeholders. Under the § 20 SGB V framework, the GKV-S and the ZPP function as centralised gatekeepers, whose certification is required to access the statutorily reimbursed preventive-health market. In contrast, under the § 140a SGB V framework, individual insurers act as autonomous strategic partners in direct, individualised negotiations. This dynamic implies the necessity of an adaptable business model capable of either satisfying the universal standards of the gatekeepers for broad market access or articulating a unique value proposition for a direct partnership. Finally, the influence of non-institutional stakeholders, particularly parents and advocacy groups, makes trust a key competitive advantage. By embedding stringent data privacy and transparent, non-manipulative design into its core, the business model can turn regulatory compliance and ethical positioning into a strategic asset that differentiates it from both gaming monetisation schemes and advertising-based health platforms. Fundamental to this strategy is the integration of healthcare and educational professionals. Their expertise is the mechanism for satisfying the evidence-based standards of institutional stakeholders, which is a prerequisite for B2B market access. Simultaneously, their involvement builds essential parental trust for B2C market acceptance, leveraging the principle of trust transfer from credible professionals to the digital service. This professional backing, therefore, serves as the foundational component of the model's legitimacy, transforming ethical design from a compliance requirement into a market differentiator.

4.2.2.3 Synthesis of Key Trends

The analysis of key environmental trends provides a set of formative implications that directly shape the strategic design of the HealthGrind business model. Technological, sociocultural, socioeconomic, and regulatory forces collectively define the market opportunities and the essential operational and ethical foundations for the intervention. A viable model would need to leverage established user behaviours, tailor its approach to address socioeconomic disparities, and strategically embed regulatory compliance as a foundational design principle.

The core value proposition is derived from the synthesis of technological and sociocultural trends. The intervention will prioritise commercially validated mechanics with demonstrated effectiveness, such as location-based gamification, over speculative innovations like AI, which currently lack robust evidence for behavioural impact. AI-driven features remain speculative given current evidence limitations and would require pilot validation before consideration as premium features. This established technology will be applied to a powerful, pre-existing sociocultural motivation: the high perceived (social) value of in-game digital goods. Consequently, the intervention hypothesises that gaming-integrated incentives may succeed where generic reward mechanisms have failed by redirecting adolescents' existing motivation for digital rewards towards PA, though this proposition requires empirical validation. The temporal growth in gaming engagement, particularly the intensification during adolescence, reinforces the viability of this approach by confirming that gaming represents an increasingly stable behavioural context within which such interventions can operate.

The observed socioeconomic patterns in gaming engagement and spending indicate that lower-SES adolescents are both highly active in digital gaming and disproportionately exposed to microtransaction costs. Ensuring equitable access and maximising engagement would require a no-cost or subsidised model. By providing a non-monetary, effort-based pathway to digital rewards, the programme aims to leverage the motivation of this demographic towards health-promoting behaviour whilst mitigating financial barriers.

The European regulatory landscape establishes the foundational ethical framework for the business model. The stringent requirements of the GDPR and the DSA impose a non-negotiable commitment to data privacy and non-manipulative design. Specifically, the GDPR necessitates the implementation of a verifiable parental consent mechanism for users under the age of 16, establishing a critical operational

parameter from the outset. While the DSA's prohibition of profiling-based advertising for minors forecloses a targeted advertising model, it leaves room for a compliant secondary revenue stream through generalised, non-targeted advertisements. Furthermore, the emerging EHDS framework offers a strategic opportunity to voluntarily pursue an EU-wide quality label, which would serve as a powerful, verifiable trust signal for both B2C and B2B customer segments.

Finally, the specific legal pathways for B2B market entry in Germany present distinct constraints and opportunities. HealthGrind could be structured to comply with the § 20 SGB V framework by removing its reward system and operating as a fixed-duration digital health course. This would allow broad market access through the centralised ZPP certification. However, the cost of this compliance would be the elimination of the intervention's primary motivational driver, thereby undermining its core value proposition and jeopardising its potential effectiveness with the target demographic. Conversely, the § 140a SGB V pathway appears more accommodating to the reward-based model, as its terms are subject to direct negotiation. This route, however, is not without constraints, as it requires insured persons to actively declare their participation, potentially limiting uptake.

The analysis therefore concludes that the § 140a SGB V pathway represents the most viable framework for the HealthGrind concept, though no precedents for reward-based PA interventions funded through § 140a contracts were identified within the scope of this thesis. While other regulatory options may exist beyond the scope of this thesis, the direct conflict between the § 20 SGB V framework and the intervention's core reward mechanic renders it fundamentally incompatible. Consequently, the subsequent Business Model Canvas will be developed based on the flexible, partnership-oriented model offered by § 140a SGB V. This represents an untested market entry strategy that will require careful partnership development.

4.2.2.4 Synthesis of Macroeconomic Forces

The analysis of macroeconomic forces reveals a complex but navigable environment for a new venture. The primary implication is that while broad economic conditions necessitate a cautious financial strategy, specific market resilience, a supportive public policy landscape and a well-defined economic infrastructure provide a viable pathway for the HealthGrind business model. The model's success will be contingent upon its ability to align its financial, funding and operational plans with these external realities.

A core finding is that despite a stagnating national economy, the German market presents a clear opportunity for a B2C business model. The stability of domestic demand, particularly the continued strong growth in household spending on health-related goods and services, confirms that a market exists for health-promoting interventions. This indicates that the venture's viability is less dependent on a broad economic recovery and more contingent on its ability to capture a share of this pre-existing, resilient consumer expenditure. Consequently, the business model requires a value proposition that captures resilient health spending whilst remaining accessible to cost-conscious consumers, indicating tiered subscription pricing as an appropriate structure. The macroeconomic environment presents distinct implications for the § 140a SGB V pathway identified as the primary market entry route. Economic stagnation may constrain SHIs' willingness to fund experimental interventions lacking effectiveness evidence, though fiscal pressure simultaneously creates incentives for cost-effective preventive strategies, suggesting that partnership viability will depend on demonstrating clear economic value propositions. The revenue model faces a substantial infrastructure burden, where platform fees and VAT alone capture approximately 30% of gross consumer payments before operational costs. This burden necessitates pricing strategies ensuring sufficient margin remains after mandatory deductions.

The analysis of the capital markets indicates a two-phase funding strategy. Given the VC market's declining confidence and concerns over valuations, the analysis indicates prioritising public grants as initial funding sources. The government's Start-up Strategy, through programmes like EXIST, supports research-based ventures with funding, and the 'Förderdatenbank' provides a central platform for finding these funding opportunities. Following this foundational public funding, the analysis indicates pivoting to the private capital market, where business angels supported by instruments like the INVEST grant represent a more viable source of follow-on financing than traditional VC. The sustained investor interest in the health sector strengthens HealthGrind's positioning for funding access, though investor due diligence will require addressing the absence of established effectiveness evidence for reward-based mHealth interventions identified in the systematic review, necessitating clear articulation of how gaming-integrated rewards may differ from previously tested standalone reward mechanisms, and an evidence generation strategy.

Finally, the analysis of the labour market has direct and significant implications for the business model's operational plan and cost structure. The analysis of the labour

market indicates two distinct risks to the business model's execution. The intervention's technical development is constrained by limited availability of software development experts. The second is a content credibility risk, stemming from the challenges in recruiting physiotherapy specialists needed to design safe, age-appropriate PA programmes. This health expertise is fundamental to ensuring user safety and achieving market acceptance. The labour market analysis reveals a critical mismatch between required personnel costs for bottleneck occupations and available early-stage funding. The business model therefore requires structuring partnerships that provide access to software development and physiotherapy expertise without bearing full employment costs during pre-revenue phases, such as equity-based compensation arrangements, outsourced development contracts, or collaborations with health organisations employing the required specialists.

4.2.3 Foundational Design Decisions

The environmental analysis necessitates three foundational strategic decisions that collectively determine the business model architecture developed in the subsequent Business Model Canvas.

First, the business model will operate within the § 140a SGB V legal framework (Special Care Contracts) rather than the § 20 SGB V standardised prevention pathway. As established in the Key Trends synthesis, the § 20 framework's prohibition of recurring revenue models and its requirement for time-limited interventions are structurally incompatible with the reward-based mechanism that constitutes HealthGrind's core value proposition. The § 140a pathway, whilst requiring selective contracting with individual SHIs rather than universal market access, permits the flexible bilateral agreements necessary to accommodate gaming-integrated rewards.

Second, the business model will employ a partnership-based reward procurement system whereby game publishers supply digital rewards without direct monetary exchange, rather than a self-funded model requiring direct purchase of rewards such as gift cards. This determination rests on structural economic and strategic considerations identified in the environmental analysis. The partnership approach addresses competitive threats by transforming potential insurgents into collaborators, enabling integration into established gaming ecosystems rather than competing against them. Critically, partnerships enable distribution of contextually relevant, high-value digital rewards without incurring substantial variable costs that would compromise financial sustainability. Conversely, the self-funded approach would position reward costs as a primary variable expense, necessitating higher pricing that

would contradict accessibility objectives for lower-socioeconomic segments whilst reducing the business model to a commodity reseller function with limited competitive differentiation.

Third, this partnership-dependent architecture operates under unproven assumptions requiring explicit acknowledgment. The systematic literature review established that generic reward-based mHealth interventions have not demonstrated effectiveness in methodologically robust trials, and that gaming-integrated reward mechanisms remain empirically untested rather than validated. The viability of publisher partnerships is similarly unproven, as the Industry Forces analysis identified that publishers require assurance that PA integration does not negatively affect player engagement or retention, yet no effectiveness data currently exists to provide this assurance. The business model therefore functions as hypothesis-driven strategic positioning contingent on future empirical validation through pilot implementation, rather than evidence-confirmed market entry.

4.2.4 Business Model Canvas

This section presents the hypothetical business model for the HealthGrind intervention, structured according to the Business Model Canvas framework. The model is contingent on future empirical validation of the core intervention mechanism, as established in the systematic review (4.1) and the foundational design decisions (4.2.3). Each component is a direct implication of the environmental analysis.

Customer Segments

The model targets three distinct customer groups. The primary end-users are video game-playing ChAd who face financial barriers to in-game reward acquisition, specifically non-paying Grinders and low-spending Minnows. Secondary end-users include higher-spending gaming segments (Dolphins, Whales), for whom the model is positioned as access to limited and rare rewards. Within the B2C market, parents function as paying customers and decision-makers, with higher-SES households representing the core segment for premium offerings. The B2B segment comprises individual SHI operating under §140a SGB V, each representing an autonomous contracting entity.

Value Propositions

The model offers tailored value propositions that address the specific needs of each segment. For ChAd End-Users, the value proposition is tiered. A freemium tier offers a non-monetary pathway to acquire valued in-game digital goods by converting PA into effort-based rewards with their smartphones. The premium tier enhances this

value with advanced features, including wearable device integration which enables expanded challenge variety and more sophisticated reward mechanisms. For parents, it offers a professionally validated, ethically designed digital tool that integrates PA into established gaming routines as an alternative to microtransaction-based monetisation. For SHIs, the value is a fully compliant and evidence-based digital prevention service that can be procured via a Special Care Contract § 140a SGB V. For Game Publishers, the value is a specialised partnership service that enhances brand reputation and addresses gaming-related health stigma, outsources management of technical and regulatory complexities of health data integration, and provides an additional promotional channel for their games through health-based engagement mechanisms.

Channels

The channel strategy integrates digital and physical touchpoints to reach all segments. The primary distribution channel is through digital app stores, namely the Apple App Store and Google Play Store. Awareness and acquisition channels for ChAd end-users include social media, gaming-centric platforms like Twitch and in-game promotions via publisher partners to showcase their collaborative health promotion partnership with HealthGrind. For parents, acquisition employs healthcare and educational professionals as credibility channels, supplemented by digital marketing targeting parental demographics and potential school-based distribution. B2B access requires direct negotiation with individual SHI through industry conferences, health innovation networks, and insurer innovation departments.

Customer Relationships

The model employs distinct relationship strategies. For end-users and parents, the relationship is an automated service where trust is established through verifiable parental consent mechanisms (GDPR Art. 8) and transparent data policies (DSA Principles). Relationships with SHIs are structured as dedicated strategic partnerships requiring co-creation, robust performance reporting and continuous evidence generation. For game publishers, the relationship is that of a strategic partner and supplier, managed through a dedicated analytics platform to provide verifiable data on reward-challenge efficacy and engagement analytics.

Revenue Streams

Primary revenue needs to be negotiated through §140a contracts with individual SHIs, employing flexible fee structures such as per-member fees, performance-based payments, or hybrid models. These contracts may also cover premium service tiers

for low-SES populations, ensuring equitable access to advanced features. Secondary B2C revenue operates through tiered subscriptions. Premium pricing capturing higher-SES willingness-to-pay and basic or freemium access guaranteeing universal entry. A tertiary stream may be generated from contextual, non-targeted advertising that is fully compliant with the Digital Services Act (DSA).

Key Activities

Core operational activities include platform development, specifically the integration with platform health APIs and publisher reward APIs. A second key activity is professional content creation, involving the design of safe and effective PA programmes by qualified physiotherapy and pedagogical specialists. Further activities include conducting prospective evaluation studies to generate effectiveness evidence and maintaining continuous regulatory compliance with GDPR, DSA, and emerging EHDS frameworks.

Key Resources

Essential human capital includes software development experts (bottleneck occupation, median €6,097 monthly) and physiotherapy specialists (bottleneck occupation, median €3,248 monthly), supplemented by pedagogical/psychological and business expertise. Intellectual resources encompass the GDPR-compliant parental consent system, reward distribution algorithms, and effectiveness datasets. Technical infrastructure comprises platform API access, wearable device integration capabilities, and healthcare-grade hosting systems. Financial resources follow staged funding: initial public grants (EXIST, BMWK instruments) transitioning to business angel investment potentially enhanced through INVEST co-financing.

Key Partnerships

The business model is contingent upon a network of essential partners. Game publishers function as strategic suppliers, providing the non-monetary supply of digital rewards upon which the model has absolute operational dependency. Individual SHI are strategic customers providing market access and revenue. Platform owners (Apple, Google) are key suppliers controlling the distribution and data access infrastructure. Finally, Wearable device manufacturers offer enhanced data accuracy and potential co-marketing opportunities.

Cost Structure

Fixed structural costs include platform fees (15-17% of digital transactions), value-added tax (19%), corporate taxes (approximately 32% combined rate), and GmbH formation requirements (€25,000 minimum capital plus registration costs). Variable

personnel costs dominate operational expenditure, with software development and physiotherapy expertise representing key labour market bottlenecks. Additional variable costs encompass technical infrastructure scaling with user volume, B2C and B2B customer acquisition, regulatory compliance activities, and evidence generation investments.

4.2.5 Synthesis (Business Model Blueprint)

The Business Model Canvas constitutes a hypothesis-driven strategic framework rather than a validated operational model. The Canvas functions as a blueprint that systematically exposes critical dependencies requiring empirical resolution: whether game publishers will commit to sustained partnerships supplying digital rewards, whether statutory health insurers will negotiate § 140a contracts providing sufficient revenue, and whether the cost structure permits financial sustainability given platform fees, taxation burdens, and labour market constraints.

Regarding preliminary feasibility assessment, the business model demonstrates conditional viability within a microtransaction-dominant gaming industry, though this assessment rests on untested propositions. The model positions effort-based progression as a complementary pathway rather than a displacement strategy, targeting user segments for whom financial barriers limit in-game progression (non-paying Grinders, low-spending Minnows) whilst addressing parental and regulatory concerns regarding manipulative monetisation practices. For higher-spending segments (Dolphins, Whales), the model offers exclusive, effort-gated rare rewards unavailable via purchase, representing the only identified pathway to engage users for whom instant gratification through payment is not a barrier (Rockloff et al., 2020, pp. 24–25). The feasibility argument draws on three established precedents: grinding mechanics represent validated game design patterns where players willingly invest sustained effort to earn progression rewards (Rehbein et al., 2024), battle pass systems in games like Fortnite demonstrate that hybrid models combining initial purchases with effort-based unlocking achieve commercial success (Meschik et al., 2024, p. 248), and Twitch Drops campaigns confirm publishers' structural willingness to distribute in-game rewards through third-party platforms when aligned with marketing objectives (Twitch Interactive Inc., 2025).

However, these precedents do not demonstrate that physical activity can substitute for in-game grinding or produce health benefits without context-specific risks. Viability remains contingent on staged empirical validation testing whether gaming-integrated rewards overcome the effectiveness limitations of decontextualised approaches,

whether publishers commit to sustained partnerships, and whether the intervention demonstrates cost-effectiveness justifying SHI investment.

5. Discussion

5.1 Summary of Principal Findings

The systematic literature review identified nine studies investigating reward-based mHealth interventions targeting youth PA. Four distinct reward categories emerged: virtual rewards, social rewards, financial or prize-based incentives, and altruistic rewards. The effectiveness analysis revealed a critical inverse relationship between methodological rigour and reported benefits. Studies assessed as having critical or serious risk of bias consistently reported positive effects, whilst the three RCTs with lower risk of bias, including the largest trial with 6,640 participants, found no intervention effects. This pattern suggests that apparent benefits in lower-quality studies may reflect methodological artefacts rather than genuine intervention effectiveness. Notably, no identified studies recruited participants based on gaming engagement or integrated rewards into established gaming ecosystems. All interventions employed standalone applications requiring adoption of unfamiliar technologies outside users' existing routines.

The business model analysis identified substantial challenges and opportunities for implementing such an intervention within the German health market. Two viable market entry pathways were identified within the statutory health insurance system. The standardised prevention market under § 20 SGB V offers broad scalability but operates under rigid, time-limited funding models that, based on this analysis, would likely exclude continuous reward mechanisms, though this interpretation requires regulatory confirmation. The Special Care Contract pathway under § 140a SGB V permits flexible bilateral agreements and limits market access to individual contracting partners. The business model articulated a partnership-dependent framework contingent on collaboration with game publishers to supply digital rewards, supplemented by tiered B2C subscription revenue. However, this framework operates under unproven assumptions requiring empirical validation.

5.2 Interpretation of Findings Within the Research Landscape

5.2.1 Systematic Review Findings in Context

The systematic review findings align with broader patterns in digital health intervention research, where studies with weaker methodological designs disproportionately report positive effects. The two studies reporting the strongest positive effects both

employed single-arm, pre-post designs that cannot distinguish intervention effects from natural temporal variations or regression to the mean (Schoeppe et al., 2020; Cummings et al., 2022). Conversely, the three largest randomised controlled trials consistently found no significant effects across diverse reward types and intervention structures (Champion et al., 2023; Tugault-Lafleur et al., 2023; Wunsch et al., 2024). This pattern suggests that the failure of reward-based mHealth interventions may reflect fundamental limitations in applying decontextualised reward mechanisms rather than inadequacies of specific reward categories.

Critically, none of the identified studies tested rewards embedded within pre-existing motivational ecosystems that already command youth engagement. All interventions required participants to adopt new technologies and engage with unfamiliar platforms, creating dual adoption barriers: learning new digital environments whilst simultaneously adopting new PA behaviours. Two contextual factors may moderate intervention effectiveness beyond reward type. Baseline activity levels varied substantially, with some participants already exceeding WHO recommendations (Peuters et al., 2024; Wunsch et al., 2024), potentially creating ceiling effects. Conversely, three studies specifically recruited adolescents with overweight or obesity (Cummings et al., 2022; Stasinaki et al., 2021; Tugault-Lafleur et al., 2023), a population that may face distinct barriers to PA. This heterogeneity prevents determination of whether reward mechanisms might be effective for specific subpopulations.

The financial reward study warrants particular attention. Despite reporting positive effects, the critical risk of bias prevents causal inference, and the substantial investment required ($510 per participant) appears economically unsustainable for scalable public health interventions (Cummings et al., 2022). The competitor analysis demonstrated that existing step-tracking applications employ small-scale financial rewards through advertising revenue rather than direct cash outlays. However, this review identified no empirical evidence demonstrating that such small-scale rewards can motivate sustained PA in youth populations.

5.2.2 Business Model Findings in Context

The business model analysis contributes to three research domains: business model framework application in digital health, regulatory positioning in the German health market, and partnership-based sustainability models for mHealth interventions.

The environmental analysis identified industry forces and regulatory constraints specific to youth-focused prevention interventions operating at the intersection of

health, gaming, and consumer technology sectors. Velayati et al. (2022) identified the Osterwalder framework as frequently used for analysing digital health interventions, whilst Korsgaard et al. (2021) and Van Limburg et al. (2015) demonstrated its utility for stakeholder analysis and healthcare environment alignment. The present analysis extends application of this framework by examining competitive threats from gaming industry actors possessing established user bases, supplier power of platform owners controlling health data APIs and distribution infrastructure, and youth-specific data protection regulations that eliminate profiling-based advertising revenue models (DSA Article 28) whilst creating mandatory parental consent structures (GDPR Article 8). The competitor analysis revealed that existing step-tracking applications (WeWard, Macadam) offer rewards through advertising and retail partnerships, yet these platforms lack parental consent mechanisms for survey participation by users under 16, creating potential regulatory exposure. This finding demonstrates that regulatory compliance can function as competitive differentiation rather than merely an operational constraint.

The regulatory analysis produced practical guidance for prevention interventions employing continuous incentive mechanisms within the German statutory health insurance system. The Prevention Guideline explicitly excludes interventions "tied to existing or future memberships" and "designed as permanent offers" (Hupfeld & Siebeneich, 2024, p. 74), creating structural incompatibility between the § 20 SGB V standardised prevention pathway and reward systems requiring sustained user engagement. The § 140a SGB V Special Care Contract pathway permits flexible bilateral agreements with individual statutory health insurers, accommodating innovative intervention designs excluded from standardised frameworks whilst limiting market access to selective contracting partners. This finding has implications for any German prevention intervention employing ongoing incentive mechanisms rather than time-limited educational courses, as it articulates a trade-off between innovation flexibility and market scalability not systematically addressed in existing digital health business model literature.

The foundational decision to pursue publisher partnerships rather than self-funded reward procurement addresses sustainability challenges in gaming-integrated health interventions. Diment et al. (2024) identified that service-focused digital health interventions require structured analytical frameworks to achieve commercial viability. The present analysis articulates why partnership-based models are structurally necessary rather than merely preferable for gaming-integrated approaches: gift card procurement would position rewards as primary variable costs requiring higher pricing

that contradicts accessibility objectives, whilst publisher partnerships enable distribution of contextually relevant digital rewards without direct monetary exchange. However, the Industry Forces analysis identified Electronic Arts' discontinued activity-tracking collaboration with Adidas (Petzold, 2020) as the only documented similar attempt at gaming-health integration, with failure mechanisms remaining undisclosed. Whether barriers were technical, commercial, regulatory, or strategic cannot be determined from available evidence. The partnership-dependent business model therefore operates under unvalidated assumptions requiring empirical testing through pilot implementations. This evidence void distinguishes the present analysis from prior applications of the Osterwalder and Pigneur framework in mHealth contexts, which examined interventions with established stakeholder relationships rather than hypothetical partnerships with industries whose monetisation models may conflict with health objectives. The macroeconomic analysis identified staged public funding through instruments like EXIST as the appropriate mechanism for generating missing effectiveness evidence within academic contexts before commercial implementation, resolving the sequential dependency wherein SHIs require evidence justifying investment before contract negotiation, yet effectiveness evidence cannot be generated without initial funding.

5.2.3 Contribution to Knowledge and Research Gaps

This thesis makes three distinct contributions. This work provides a systematic synthesis of reward-based mHealth interventions specifically targeting ChAd, revealing fundamental weaknesses in the identified evidence base. Whilst prior meta-analytic work demonstrated that individualised mHealth interventions show superior outcomes compared to standardised approaches for youth PA promotion (Baumann et al., 2022), the present review identifies that reward mechanisms have not been rigorously evaluated through designs capable of isolating their independent contribution. No identified studies employed factorial or dismantling designs that would permit determination of whether rewards enhance intervention effectiveness beyond other behavioural components. Second, the thesis identifies a critical mismatch between intervention design strategies and youth digital behaviour patterns. The systematic review established that all identified interventions employed standalone applications requiring adoption of new technologies outside users' established routines. This design approach conflicts with evidence that near-universal gaming engagement and substantial in-game spending behaviours demonstrate that gaming ecosystems already command youth attention and motivational investment (Jennewein et al., 2025, p. 4; Meschik et al., 2024, p. 43; MPFS, 2024, p. 49). The

HealthGrind concept addresses this gap by proposing integration of PA rewards directly into established gaming contexts, though whether this approach can overcome the effectiveness limitations demonstrated by generic reward mechanisms remains an empirical question. Third, the business model analysis articulates the substantial regulatory and market positioning challenges confronting youth-focused digital health interventions in Germany, identifying the Special Care Contract pathway under § 140a SGB V as the only viable market entry route within the frameworks examined in this analysis. Critically, the resulting Business Model Canvas functions as a structured framework guiding evidence generation efforts by systematically identifying the unvalidated assumptions that must be empirically tested before commercial implementation becomes viable. The Canvas thereby serves dual purposes: providing strategic positioning for eventual market entry whilst defining the specific research agenda required to achieve that entry. These findings provide practical guidance for researchers and entrepreneurs developing novel youth mHealth interventions within the German health market.

The research gaps identified through this work extend beyond effectiveness evaluation. The systematic review revealed complete absence of studies examining reward schedules, magnitude, or dose-response relationships (frequency, size, effort-to-reward ratios). This limitation prevents determination of optimal reward structures that might maximise motivation whilst minimising costs. Additionally, no studies examined the durability of reward effects beyond intervention completion or investigated whether reward-motivated PA persists after reward removal, a critical question for determining whether such interventions produce lasting behaviour change or merely temporary compliance. A particularly concerning gap is the absence of research examining potential adverse effects of reward-based interventions. The systematic review identified no studies that evaluated unintended negative consequences of reward mechanisms, such as creating unhealthy associations between PA and external rewards that might undermine intrinsic motivation, or producing negative psychological effects when participants fail to achieve reward criteria. This broader research gap in adverse effects assessment has relevance for the HealthGrind concept, which positions itself as a harm-reduction alternative to microtransaction-based monetisation and the problematic gaming behaviours associated with such systems.

However, because gaming-integrated reward mechanisms remain entirely untested, no empirical evidence exists to confirm whether such approaches function as harm-reduction interventions or might introduce context-specific risks, such as reinforcing

problematic gaming patterns. Research examining both beneficial and potentially harmful consequences of gaming-integrated reward systems represents a critical priority based on the gaps identified in this review.

5.3 Strengths and Limitations

The systematic literature review employed established methodological frameworks (PRISMA 2020, Cochrane RoB-2, ROBINS-I) ensuring transparency and reproducibility. The intentionally broad eligibility criteria enabled comprehensive assessment of how reward-based interventions are currently implemented in real-world contexts, appropriately prioritising ecological validity. The risk of bias assessment systematically identified methodological limitations across all included studies, providing essential context for interpreting effectiveness claims. However, substantial methodological limitations constrain confidence in the review findings. The decision to search a single database potentially excludes relevant studies indexed elsewhere. The restriction to English and German publications similarly limits comprehensiveness. The single-reviewer approach for study selection, data extraction, and risk of bias assessment increases susceptibility to selection bias compared to dual independent screening protocols typically employed in rigorous systematic reviews. These methodological constraints indicate that the review findings should be interpreted as indicative rather than definitive. The simplified risk of bias assessment did not implement complete RoB-2 or ROBINS-I protocols, potentially affecting the precision of bias judgements. The inability to conduct meta-analysis due to substantial heterogeneity prevented quantitative synthesis. The narrative synthesis approach relies more heavily on subjective interpretation compared to statistical pooling. The absence of publication bias assessment represents a notable limitation, particularly given that the observed inverse relationship between methodological quality and reported effectiveness suggests potential selective reporting favouring positive findings from lower-quality studies.

The business model development employed a validated framework documented in digital health research (Velayati et al., 2022), providing methodological rigor to the business model generation process. The comprehensive environmental analysis systematically examined market forces, industry dynamics, regulatory trends, and macroeconomic conditions, providing an evidence-based foundation for strategic decision-making. However, the business model analysis possesses inherent limitations.

The environmental analysis represents a snapshot at a specific time point, with market forces and regulatory frameworks evolving continuously. Furthermore, whilst the analysis employed the Osterwalder & Pigneur framework's guiding questions to structure the four environmental domains (4.2.1), sources were identified through exploratory rather than systematic search methods. This approach, whilst appropriate for business model environmental scanning, means potentially relevant market analyses, regulatory developments, or industry reports may not have been captured. The competitor analysis was limited to the top 100 Health & Fitness applications in the Apple iOS App Store, potentially excluding relevant competitors. The labour market analysis relied on aggregated median salary data without experience-stratified compensation information necessary for precise cost estimation. Most critically, the business model is predicated on unvalidated assumptions regarding both intervention effectiveness and partnership viability. Similarly, the partnership-dependent framework assumes that game publishers will collaborate to supply digital rewards, yet no precedent was identified in this analysis for such partnerships in the youth health intervention market, with past attempts encountering unresolved barriers. These unvalidated assumptions indicate that the business model functions as hypothesis-driven strategic positioning rather than evidence-confirmed market entry strategy.

An additional conceptual limitation concerns the broad age range targeted by both the systematic review and business model. Whilst Baumann et al. (2022) demonstrated that individualised mHealth interventions show superior outcomes, attempting to address both children (6-13 years) and adolescents (14-17 years) within a single business model creates contradictory design demands. The cognitive development differences between these groups may necessitate different interface designs, reward structures, and engagement strategies. The MPFS (2024) data demonstrating that gaming time peaks during adolescence (103 minutes daily among 14-15 year-olds) whilst smartphone ownership becomes ubiquitous suggests that focusing exclusively on adolescents would have provided clearer design parameters and a more homogeneous target population. This overly broad demographic scope may have obscured age-specific effectiveness patterns in the systematic review and complicated the business model's value proposition development.

5.4 Implications for Practice and Future Research

The findings generate concrete implications for practitioners developing youth PA interventions. First, the evidence identified in this review suggests that standalone reward-based mHealth interventions are insufficient to support their use as validated

approaches for promoting sustained PA in ChAd, though this finding is limited to decontextualised rewards and does not address gaming-integrated mechanisms. The consistent null findings from methodologically robust trials indicate that such interventions are unlikely to produce meaningful behaviour change when implemented as currently conceptualised. Second, for practitioners pursuing novel intervention development within the German health market, the regulatory analysis provides actionable guidance. The § 20 SGB V standardised prevention pathway's prohibition on selling byproducts creates ambiguity regarding reward mechanism compatibility. Whilst this analysis interpreted rewards as potentially excluded, practitioners should seek direct clarification from the ZPP, as alternative interpretations may permit certain reward implementations. Practitioners developing interventions falling outside the time-limited, course-based structure should pursue the § 140a SGB V Special Care Contract pathway, which permits flexible bilateral agreements with individual SHIs.

Rigorous evaluation of gaming-integrated reward mechanisms requires randomised controlled trials with objective measurement, extended follow-up, gaming-based recruitment, and factorial designs isolating reward contributions. Gaming-integrated rewards might utilise approaches demonstrated feasible in pilot work, such as gift cards for game purchases (Haghighi Fashi, 2025), whilst exploring partnerships with smaller publishers seeking to test innovative game designs that differentiate themselves in markets dominated by established brands. Additionally, research examining reward schedules, magnitude, and dose-response relationships would be valuable for optimising intervention design. Studies should systematically vary reward frequency, size, and effort-to-reward ratios to identify structures that maximise motivation whilst minimising costs. Additionally, examining the durability of reward effects after reward removal is essential to determine whether reward-based interventions produce lasting behaviour change or merely temporary compliance.

Beyond effectiveness questions, investigation of potential adverse effects represents a critical research gap identified through this review. Studies should examine whether reward-based PA interventions inadvertently reinforce problematic gaming patterns, create unhealthy associations between PA and external rewards that undermine intrinsic motivation, or produce negative psychological effects when participants fail to achieve reward criteria. Furthermore, the viability of publisher partnerships identified as essential for sustainable business model implementation remains empirically untested. Research should examine how PA routines can coexist with established gaming habits rather than competing for time. A fundamental question

remains whether physical activity can functionally substitute for in-game grinding without introducing context-specific risks or undermining the motivational frameworks that make grinding effective within gaming contexts. Studies must examine not only whether gaming-integrated rewards increase PA, but whether this mechanism produces health benefits without reinforcing problematic gaming patterns.

Finally, research examining intervention effectiveness across socioeconomic strata is essential given the identified disparities in gaming engagement and spending patterns.

6. Conclusion

This thesis investigated whether reward-based mHealth interventions effectively promote PA in ChAd and sought to develop a viable business model for implementing gaming-integrated rewards within the German health market. The dual inquiry produced definitive findings on intervention effectiveness whilst revealing fundamental structural dependencies that determine commercial viability. The systematic review objective has been fully achieved: it answered both research questions by identifying four reward typologies and evaluating their effectiveness, establishing that standalone reward-based interventions have not demonstrated effectiveness in rigorous trials. Further, the review also identified no interventions similar to the HealthGrind concept, revealing a research gap for contextualised reward-based mHealth interventions that embed rewards within pre-existing motivational ecosystems. The business model objective has been addressed through development of a strategic blueprint that systematically identifies the unvalidated assumptions, regarding intervention effectiveness, publisher partnerships, and cost structures, that must be empirically resolved before commercial viability can be determined.

Research Questions Answered

Regarding intervention effectiveness, the evidence from this systematic review indicates a consistent pattern. Among the identified studies, reward-based mHealth interventions, as currently conceptualised and evaluated, have not demonstrated effectiveness in promoting youth PA when assessed through methodologically rigorous designs. Three randomised controlled trials with lower risk of bias, collectively enrolling over 7,000 participants, uniformly reported null effects.

Business Model Viability Assessment

The business model analysis suggests conditional commercial viability within the German health market, contingent on resolving three interdependent uncertainties: regulatory positioning, publisher collaboration, and financial sustainability.

Regulatory analysis identified § 20 SGB V as likely excluding continuous reward mechanisms, whilst § 140a SGB V permits them through bilateral agreements that sacrifice universal market access. Publisher partnerships are essential yet unproven: Electronic Arts' discontinued activity-tracking collaboration with Adidas demonstrates industry exploration of this model but with unresolved barriers. While established gaming practices (grinding mechanics, battle pass systems, third-party reward distribution via Twitch) demonstrate that effort-based progression models are viable within gaming contexts, these precedents do not evidence that physical activity can functionally substitute for in-game grinding. Whether smaller publishers seeking market differentiation will commit to sustained partnerships remains empirically untested.

Finally, cost structure analysis revealed substantial fixed burdens from platform fees and taxation, compounded by labour market constraints in software development and physiotherapy expertise. Revenue viability depends on negotiating § 140a contracts providing sufficient per-member fees whilst maintaining accessible B2C pricing.

The Evidence-to-Market Pathway

The thesis identified a critical sequential dependency that determines implementation strategy. Commercial market viability requires effectiveness evidence that was not identified in this review, as gaming-integrated rewards remain entirely untested whilst standalone reward mechanisms demonstrated null effects in rigorous trials. This represents a fundamental empirical void rather than a modest research gap requiring novel methodological approaches. The business model analysis determined that the § 140a SGB V pathway permits innovative intervention designs employing continuous reward mechanisms excluded from standardised prevention frameworks, yet SHIs require evidence justifying investment before contract negotiation. Whether rewards embedded within pre-existing gaming ecosystems overcome the limitations of decontextualised approaches remains an empirical question.

This evidence requirement indicates that conventional direct-to-market pathways do not apply. Instead, staged public funding through instruments like the EXIST programme provides the appropriate mechanism for generating missing effectiveness evidence within academic contexts, transitioning to commercial implementation and private capital only after validation reduces investment risk. This sequential pathway

resolves the dependency by enabling pilot implementation without requiring prior commercial viability demonstration.

Contributions and Implications

The inverse relationship between methodological quality and reported benefits suggests systematic bias in the intervention development pipeline. These findings indicate that decontextualised reward mechanisms do not warrant continued investment in their current form. The identification of gaming ecosystems as entirely untested intervention contexts reveals a fundamental design-reality mismatch. German adolescents average 103 minutes daily in gaming environments where they demonstrate established motivation for digital rewards, yet no interventions leverage these pre-existing frameworks. This represents not an application gap but a conceptual limitation in current intervention design. HealthGrind addresses this by positioning effort-based progression as complementary to rather than competitive with instant-gratification monetisation.

This thesis establishes that gaming-integrated reward mechanisms represent an empirically untested alternative to the decontextualised approaches that failed in rigorous trials. The Business Model Canvas identifies § 140a SGB V contracts as the viable regulatory pathway, contingent on staged public funding through instruments like EXIST to generate missing effectiveness evidence before commercial implementation. Only through factorial trial designs with objective measurement and extended follow-up can the fundamental question be addressed: whether rewards embedded within pre-existing gaming ecosystems overcome the limitations of decontextualised approaches that have not demonstrated effectiveness in rigorous trials.

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Appendix A - Search Strategy

15.03.2025	PubMed	2019-2025
String Text: (children OR youth OR teen* OR minor* OR "school-age" OR preschool* OR pubert* OR prepubescent OR adolescen* OR "young people") AND ("physical activity" OR movement OR mobility OR fitness OR sport* OR exercise OR "sedentary behavior" OR "sedentary behaviour" OR "sitting time" OR "screen time") AND (intervention OR treatment OR program* OR strategy OR initiative) AND (mHealth OR "mobile health" OR "digital health" OR "smart health" OR eHealth OR "electronic health" OR "app" OR "apps" OR "smartphone" OR "wearable" OR "telehealth" OR smartwatch) AND (incentiv* OR reward* OR motivat* OR gamif* OR "behavior change" OR "behaviour change") AND (clinicalstudy[Filter] OR clinicaltrial[Filter] OR comparativestudy[Filter] OR evaluationstudy[Filter] OR meta-analysis[Filter] OR randomizedcontrolledtrial[Filter] OR systematicreview[Filter] OR validationstudy[Filter])		

Declaration of Academic Honesty

I declare that I have specifically marked all passages in this written thesis that are taken verbatim from other authors, as well as the explanations of my work that are closely based on the ideas of other authors, and that I have cited the corresponding sources. In addition, I assure that when using AI-supported writing tools, I have listed these tools in full in the section “Documentation of used AI-tools” with their product name, the source of supply and information on the functions of the software used and the scope of use. Excluded from this are those AI-supported writing tools that were classified as non-notifiable by my responsible examination office up to the time of submission of my thesis. During the whole process of the creation of this thesis, I worked independently throughout and retained control over the use of AI-supported writing tools.

Hamburg, 06.10.2025

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