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Adolescent subthreshold depression: Prevalence, risk factors, and transition to major depressive disorder: A systematic review and meta-analysis

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Systematic Review

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Abstract

Background

Adolescent subthreshold depression (SD) represents a significant public health concern. However, comprehensive global data on its pooled prevalence, associated risk factors, and longitudinal transition to major depressive disorder (MDD) remain fragmented.

Methods

A systematic search of eight electronic databases was conducted to identify relevant studies published between 2013 and 2026. Study screening, data extraction, and quality assessment were performed independently by two reviewers. Random-effects meta-analyses were employed to calculate pooled prevalence rates and effect sizes.

Results

Fifteen studies comprising 76,289 adolescents met the inclusion criteria. The global pooled prevalence of adolescent SD was 19% (95% CI: 14–24%; I^2 = 99.1%). Female sex emerged as a significant risk factor for SD (OR = 1.63, 95% CI: 1.52–1.75). Notably, baseline SD quadrupled the risk of subsequent transition to MDD (OR = 4.01), with conversion rates ranging from 8% to 24% at 2-year follow-up and a cumulative incidence of 34% at 13-year follow-up.

Conclusion

Nearly one in five adolescents globally experiences SD, which confers a substantial long-term risk of progression to full-syndrome MDD, particularly among females. These findings underscore that adolescent SD is not a transient condition but a critical window for early intervention. Implementing proactive, gender-sensitive screening protocols and targeted preventive strategies within school-based and community mental health frameworks is essential to mitigate disease progression.

1. Introduction

Adolescence represents a pivotal neurodevelopmental window characterized by rapid physiological transitions and profound psychological maturation [1]; however, it is also a period of heightened vulnerability for the onset of psychiatric disorders [2, 3]. Subthreshold depression (SD)—alternatively termed subclinical or sub-syndromal depression—is defined by clinically significant depressive symptoms that fall below the diagnostic criteria for major depressive disorder (MDD) as specified by the DSM-5 or ICD-11 [4–6]. Despite its "subthreshold" designation, accumulating evidence indicates that SD is far from a benign or transient state. Instead, it is associated with profound functional impairment,

including academic underachievement and interpersonal dysfunction [7, 8]. Crucially, SD exhibits marked diagnostic instability [9], frequently serving as a potent prodromal phenotype with a high propensity for conversion to syndromal MDD [10].

The global landscape of adolescent mental health has shifted dramatically in recent years, heavily exacerbated by the psychosocial aftermath of the COVID-19 pandemic and the pervasive influence of digital environments [11]. From an epidemiological perspective, an updated synthesis of SD prevalence is essential for robust public health planning [12]. However, the existing literature remains fragmented by two primary limitations. First, prior meta-analyses have predominantly focused on adult populations or rely on outdated search periods that fail to capture contemporary prevalence fluctuations in the post-pandemic era [13]. Second, there remains a persistent gap in synthesized evidence regarding the longitudinal trajectories of SD and the multidimensional drivers—ranging from cognitive vulnerabilities to sociodemographic risk factors—that underpin its progression to full-blown MDD [14, 15].

From the perspectives of preventive medicine and psychiatric nursing, adolescent SD represents a critical, yet underutilized, intervention window. Early identification of SD serves as the cornerstone of "Stepped Care" models [16, 17], which aim to deliver level-appropriate, low-intensity support before symptoms escalate into chronic psychiatric conditions [18, 19]. Furthermore, elucidating the evolutionary pathways from SD to MDD is vital for constructing precision early-warning systems. Given the high risk of diagnostic conversion [20], targeted interventions during this subclinical phase offer a unique opportunity to alter long-term disease trajectories and mitigate the escalating global burden of depression [21, 22].

To address these critical gaps, we conducted this systematic review and meta-analysis to provide a comprehensive, updated evaluation of the global pooled prevalence, multi-dimensional risk factors, and longitudinal transition risks of SD specifically within the contemporary adolescent population. By quantifying the exact risk of diagnostic conversion and identifying key demographic and methodological predictors, this study aims to provide robust, evidence-based support for optimizing clinical screening frameworks and formulating targeted youth mental health policies worldwide. To our knowledge, this is the first comprehensive meta-analysis to synthesize contemporary evidence on both the epidemiological profile and progression pathways of adolescent SD.

2. Materials and Methods

2.1 Protocol and Registration

This systematic review and meta-analysis were conducted in strict accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement [23]. The study protocol was prospectively registered in the PROSPERO database (Registration No.: CRD420261363218) to ensure methodological transparency and prevent evidence duplication.

2.2 Search Strategy and Study Selection

A comprehensive, multi-stage literature search was executed to identify studies evaluating subthreshold depression (SD) in adolescents, see **Additional file 1: Table S1**.

First, we systematically searched major electronic databases—including PubMed, Embase, Web of Science, Ovid, the Cochrane Library, CINAHL, China National Knowledge Infrastructure (CNKI), and Wanfang—for peer-reviewed studies published between January 2013 and April 2026. The full search strategy is provided in the **Additional files**. The search architecture utilized an optimized combination of Medical Subject Headings (MeSH) and free-text keywords capturing the core concepts of subthreshold depression (e.g., "subthreshold depressive symptoms", "subclinical depression", "minor depression", "sub-syndromal depression") and the target population (e.g., "adolescent", "youth", "juvenile"). To ensure both global comprehensiveness and precision in data extraction, the search was restricted to publications in English and Chinese.

Second, the reference lists of all retrieved articles, eligible primary studies, and relevant systematic reviews were manually screened to capture any additional consensus-compliant studies and ensure literature saturation.

2.3 Eligibility Criteria

Studies were screened and selected based on the following pre-specified PICOS (Population, Intervention/Exposure, Comparison, Outcome, Study design) framework:

The full inclusion and exclusion criteria are detailed in the **Additional files.**

2.3.1 Inclusion Criteria:

Studies were eligible if they met the following PICOS criteria:

(1) Population: Adolescents aged 12–19 years from the general or clinical population.

(2) Definition of SD: Participants exhibiting clinically significant depressive symptoms quantified by validated psychometric screening scales like PHQ-9, CES-D and BDI or semi-structured diagnostic interviews, who did not meet the full diagnostic criteria for major depressive disorder (MDD) according to DSM-5 or ICD-11.

(3) Comparator: For risk factor identification and longitudinal transition analyses, healthy peers without depressive symptoms served as the control group.

(4) Outcomes: The primary outcome was the global pooled prevalence of SD. Secondary outcomes included effect sizes (odds ratios, relative risks) for socio-demographic and clinical risk factors, as well as longitudinal conversion rates and hazard ratios reflecting diagnostic transition to clinical MDD.

(5) Study Design: Peer-reviewed cross-sectional, case-control, or prospective cohort studies.

2.3.2 Exclusion Criteria

(1) Non-Primary Research: Systematic reviews, meta-analyses, case reports, editorials, letters, and conference abstracts lacking complete data.

(2) Clinical Comorbidities: Studies focusing primarily on participants with severe organic somatic illnesses, intellectual disabilities, or comorbid major psychiatric disorders such as bipolar disorder, schizophrenia and other psychotic disorders.

(3) Data Insufficiency: Studies with missing, unextractable, or unconvertible statistical metrics such as missing cell counts, prevalence rates and variance measures where the corresponding authors failed to provide the necessary data upon request.

2.4 Data Extraction and Quality Assessment

Two reviewers independently extracted data from eligible studies using a standardized pre-piloted form. Discrepancies were resolved through consensus or arbitration by a third senior reviewer. Extracted variables covered basic study information including first author, publication year and geographical region, sample characteristics such as sample size, mean age and gender distribution, diagnostic and screening approaches, follow-up periods and quantitative outcome data.

Methodological quality and risk of bias were assessed independently by the two reviewers. The Joanna Briggs Institute critical appraisal checklist was adopted for cross-sectional studies, and the Newcastle-Ottawa Scale was used to evaluate cohort and case-control studies. Longitudinal studies scoring seven points or above were regarded as high quality with low bias risk.

2.5 Statistical Analysis

Statistical analyses were performed using R software (version 4.5.1) leveraging the and packages. All statistical tests were two-tailed, with meta metafor $P < 0.05$ indicating statistical significance.

(1) Pooled Estimates: Prevalence rates and effect sizes including odds ratios, relative risks and hazard ratios were synthesized via random-effects models with the DerSimonian-Laird method to account for inter-study heterogeneity derived from varied geographical backgrounds and research methodologies. Prevalence proportions underwent logit transformation to stabilize variance and normalize distribution prior to pooling, and final results were back-transformed for clinical interpretation.

(2) Heterogeneity and Subgroup Analyses: Inter-study heterogeneity was assessed with Cochran's Q test and quantified by the I^2 statistic. Values over 50% represented substantial heterogeneity. Predefined subgroup analyses and random-effects meta-regression were performed to explore potential heterogeneity sources, stratified by geographical region, gender composition and assessment approaches including self-report scales and clinician-rated diagnostic interviews.

(3) Publication Bias and Sensitivity Analyses: Potential publication bias was assessed visually through funnel plot asymmetry and statistically via Egger's linear regression test. Leave-one-out sensitivity

analyses were conducted to verify the stability and robustness of pooled results and identify undue influence from individual studies.

3. Results

3.1 Literature Search and Study Characteristics

The study selection flowchart is illustrated in the PRISMA diagram (Fig. 1). Our comprehensive electronic database search initially yielded 4,561 records. Following the removal of duplicates and a rigorous screening of titles and abstracts, 433 articles were retrieved for full-text eligibility assessment. Ultimately, 15 primary studies involving a total of 76,289 participants met all eligibility criteria for inclusion in this systematic review, of which 13 provided sufficient quantitative metrics for meta-analytic pooling. The detailed socio-demographic and methodological characteristics of the included studies are summarized in **Additional file 2: Table S2**.

The geographical distribution of the evidence base spanned Europe (n = 8), Asia (n = 4), South America (n = 2), and North America (n = 1), with individual study sample sizes ranging from 412 to 12,395 adolescents. Regarding the clinical operationalization of subthreshold depression (SD), the majority of the included studies defined the condition by the presence of 2 to 4 depressive symptoms persisting for a duration ranging from 2 weeks to 1 month [24, 20].

Methodological quality and risk-of-bias assessments indicated a high standard of evidence: specifically, 6 out of 10 cross-sectional studies and 4 out of 5 longitudinal cohort studies were classified as having a low risk of bias (**Additional file 3: Table S3**).

3.2 Meta-analysis of SD Prevalence

Based on data from 13 studies (N = 29,475), the pooled global prevalence of adolescent SD was 19% (95% CI: 14% to 24%). As illustrated in the forest plot (Fig. 2), prevalence estimates varied widely, ranging from 6% to 32%. Given the substantial inter-study heterogeneity (I^2 = 99.1%, P < 0.001), a random-effects model was employed for synthesis.

To systematically explore potential sources of the observed inter-study heterogeneity, pre-specified subgroup analyses were conducted across several methodological and clinical strata (detailed in **Additional file 4: Figure S1-S3**):

(1) Geographical Region: Statistically significant geographical disparities in SD prevalence were observed (X^2= 43.84, df = 3, P = 0.01). The pooled prevalence was highest in North America (25%) and Europe (20%), whereas notably lower but identical rates were identified in Asia (17%) and South America (17%). Intriguingly, within-group heterogeneity was negligible specifically within the South American subgroup (I^2 = 0%).

(2) Assessment Modality: Prevalence estimates derived from self-report psychometric scales (22%) and composite assessment tools (23%) were numerically higher than those obtained via gold-standard diagnostic interviews (14%). However, this methodological variance did not reach statistical significance (X^2= 3.26, P = 0.20).

(3) Study Setting: The contextual setting of the primary studies did not account for significant prevalence fluctuations. No significant statistical difference (P = 0.667) was captured between investigations conducted in mixed community settings (20%) and those strictly constrained to school-based environments (17%).

3.3 Meta-analysis of Risk Factors and Predictors

The systematic review identified a multifaceted array of predictors associated with adolescent SD, which were broadly categorized into sociodemographic, cognitive, and neurobiological domains.

3.3.1 Sociodemographic Factors

Female sex emerged as a highly robust and universal predictor of adolescent SD. Pooled data from four primary studies demonstrated that female adolescents faced a significantly elevated risk of developing SD compared to their male counterparts (OR = 1.63; 95% CI: 1.52 to 1.75; P < 0.001; Fig. 3). Notably, the I^2 statistic was 0%, indicating exceptional homogeneity in this female-specific vulnerability across diverse geographic and cultural populations.

3.3.2 Cognitive-Psychological Vulnerabilities

Due to substantial heterogeneity in psychological constructs and the diversity of measurement instruments across the included literature, quantitative pooling was precluded for certain cognitive dimensions; instead, these factors were evaluated via a narrative synthesis of high-quality representative data. Specifically, data from Miloseva et al. (2018) [25] revealed pronounced cognitive aberrations in adolescents with SD compared to healthy controls (all P < 0.001).

Effect size analysis leveraging Cohen's d identified a ruminative response style (RUM) as the most potent risk-conferring correlate of SD status (d = 1.56), followed by dysfunctional attitudes (DAS, d = 0.84) and a negative attributional style (ACSQ, d = 0.83). Conversely, perceived social support (MPSS) demonstrated a robust protective and inverse association with SD severity (d = -0.75). Synthetically, these findings delineate a distinct phenotype of elevated cognitive vulnerability in adolescents with SD, characterized by severe maladaptive cognitive biases, excessive rumination, and a perceived deficit in external supportive networks. These empirically validated psychological indicators provide critical, actionable targets for targeted early screening and preventative psychiatric nursing interventions.

3.3.3 Neurobiological Predictors: Longitudinal Predictive Value

Evidence from longitudinal cohort research [26] provides critical insights into the neurobiological underpinnings of adolescent SD. Prospective functional neuroimaging data demonstrated that decreased activation (hypoactivation) of the right ventral striatum at baseline serves as a significant longitudinal predictor for both the subsequent onset of SD at a 2-year follow-up (OR = 0.82; 95% CI 0.71 to 0.95; P = 0.007) and the further phenotypic escalation to syndromal MDD (OR = 0.66; 95% CI: 0.45 to 0.97; P = 0.037).

These neuroimaging findings strongly imply that functional aberrations within the frontostriatal reward-processing circuitry may constitute a primary neural substrate driving the clinical progression of depressive symptoms during adolescence. From a preventative psychiatric nursing perspective, these imaging biomarkers offer a robust, objective foundation for early risk stratification, advocating for the integration of biological vulnerabilities into precision screening protocols for high-risk youth.

3.4 Clinical Trajectory and Longitudinal Progression to MDD

Longitudinal data synthesised from cohort studies confirm that SD is a potent precursor to syndromal depression (Fig. 4).

3.4.1 Longitudinal Conversion Rates and Transition Risk

In terms of temporal progression, adolescent SD carries a substantial long-term risk of clinical deterioration. Short-term prospective tracking (at a 2-year follow-up) revealed diagnostic conversion rates to formal MDD ranging from 10% to 24% [27], whereas the cumulative incidence of full-syndrome depression escalated to 34% during extended long-term tracking spanning up to 13 years [28].

Quantifying the magnitude of this transition risk, Vulser et al. (2018) [27] provided a robust representative effect size, demonstrating that adolescents exhibiting SD at baseline faced an approximate fourfold increased risk of transitioning to clinical MDD compared to their healthy counterparts (OR = 4.01; 95% CI1.27 to 12.38).

3.4.2 Methodological Heterogeneity in Longitudinal Trajectories

It is critical to note that these longitudinal findings are characterized by marked inter-study methodological heterogeneity. This variance primarily stems from inconsistencies across literature in outcome definitions, such as gold-standard structured clinical interviews for MDD diagnosis or proxy psychometric markers like the ADRS, fluctuating attrition rates, divergent follow-up intervals, and asymmetrical approaches to confounding control. Consequently, while the longitudinal predictive power of baseline SD is clinically undeniable, precisely pinning down the exact trajectory of this transition risk requires future high-quality cohorts characterized by standardized, consensus-compliant diagnostic protocols and extended, harmonized follow-up periods.

3.5 Publication Bias and Sensitivity Analyses

Visual inspection of the generative funnel plots (**Additional file 5: Figure S4**) revealed a grossly pseudo-symmetrical distribution of the primary literature, with the majority of effect sizes tightly clustered near the apex of the inverted funnel, implying a low probability of small-study effects. Formal statistical confirmation via Egger's linear regression test validated these visual observations, demonstrating no significant evidence of publication bias for either the global pooled prevalence (P = 0.123) or the synthesized risk estimates (P = 0.218).

To systematically evaluate the stability and internal validity of our findings, a rigorous leave-one-out sensitivity analysis was performed (**Additional file 6: Figure S5**). The iteratively recalculated pooled prevalence remained remarkably stable, fluctuating within a narrow margin between 18% and 21%. This constancy indicates that the global estimates were not disproportionately driven by any single primary study. Furthermore, the targeted exclusion of the previously identified methodological outlier [26] yielded a highly concordant pooled prevalence of 20% (95% CI: 16% to 25%; **Additional file 7: Figure S6**). Taken together, these secondary diagnostics confirm the robust numerical stability and replication reliability of our primary analytic models.

4. Discussion

4.1. The Global Burden and Methodological Variance of Adolescent SD

This systematic review and meta-analysis demonstrate that subthreshold depression (SD) is a highly prevalent condition among adolescents worldwide, with a global pooled prevalence of 19%. This finding indicates that nearly one in five individuals in this formative developmental stage experiences clinically significant depressive symptoms that do not meet full syndromal criteria for major depressive disorder (MDD). Notably, our subgroup analyses revealed distinct methodological and geographical variances. The numerically higher prevalence estimates derived from self-report questionnaires (22%) compared to structured clinician-rated diagnostic interviews (14%) highlight the well-known phenomenon of symptomatic over-reporting in psychometric screening. Self-report tools capture cross-sectional affective distress, whereas diagnostic interviews enforce strict duration and functional impairment criteria, separating transient developmental turmoil from true subclinical pathology. Geographically, the lower prevalence observed in Asia (17%) relative to North America (25%) and Europe (20%) may reflect cross-cultural variations in emotional expression, distinct stigma-related reporting biases, or genuine differences in psychosocial stressors across educational systems.

4.2. Multidimensional Risk Factors: Intersecting Biology and Cognition

A major strength of this study lies in its synthesis of the multidimensional drivers of adolescent SD. Our finding that female adolescents face a significantly higher risk (OR = 1.63) with absolute across-study homogeneity (I^2 = 0%) underscores sex as a robust, universal vulnerability factor. This female-skewed disparity perfectly aligns with the onset of puberty, a period characterized by fluctuating gonadal hormones like estradiol that modulate the sensitivity of the hypothalamic-pituitary-adrenal (HPA) axis to stress [29].

Crucially, our narrative synthesis suggests that this biological vulnerability intersects with distinct cognitive-psychological phenotypes. The profound correlation between SD and a ruminative response style (d = 1.56), dysfunctional attitudes (d = 0.84), and negative attributions (d = 0.83) map out a distinct cognitive profile characterized by self-referential negative biases. Female adolescents are socio-culturally and behaviorally more prone to co-rumination, which amplifies minor affective symptoms.

From a neurobiological standpoint, our synthesis of prospective neuroimaging data [26] provides a compelling neural substrate for these clinical observations. Hypoactivation of the right ventral striatum at baseline—a core node of the mesolimbic dopamine pathway—prospectively predicted both SD onset and progression to MDD. The ventral striatum is central to reward anticipation and salience processing. Neural hypoactivation in this region clinically manifests as anhedonia and a blunted capacity to experience positive reinforcement from external supportive environments—a notion directly validated by the protective, inverse relationship found with perceived social support (d = -0.75). Consequently, adolescents with altered reward circuitry may enter a vicious cycle where neurobiological deficits drive ruminative cognitive styles, ultimately precipitating subclinical affective syndromes.

4.3. The Longitudinal Trajectory: SD as a Critical Prodromal Window

Our longitudinal synthesis firmly dismantles the misconception that adolescent SD is merely a benign, transient developmental phase. Instead, baseline SD represents an unstable, highly predictive prodromal phenotype that carries an approximate fourfold increased risk (OR = 4.01) of diagnostic conversion to MDD. The temporal metrics are striking: up to approximately one-quarter of adolescents with SD cross the diagnostic threshold to syndromal MDD within two years, with the cumulative conversion rate escalating to 34% over a 13-year period. This progressive trajectory implies that subclinical depressive symptoms exert an enduring "scar effect" or represent an early manifestation of an underlying, progressive neurodevelopmental vulnerability [30].

However, as highlighted in our results, the precise magnitude of this transition risk across the literature is obscured by notable methodological heterogeneity. Differences in outcome definitions such as using psychometric proxy scores versus formal DSM/ICD criteria via clinical interviews and variable longitudinal attrition rates create artificial fluctuations in captured conversion metrics [31]. Despite this heterogeneity, the absolute clinical direction is unambiguous: SD is a powerful early-warning indicator that bridges subclinical distress and chronic major psychiatric disorders.

4.4. Clinical and Preventative Implications for Psychiatric Nursing

From the perspective of preventative medicine and clinical psychiatric nursing, these findings establish an urgent, empirical imperative to shift the adolescent mental health paradigm from reactive treatment to proactive, early-stage interception. Early identification of SD serves as the programmatic foundation for "Stepped Care" models. Given that nearly 20% of the youth population exhibits SD, deploying high-intensity psychiatric interventions universally is logistically unsustainable [32]. Instead, integrating universal, gender-sensitive screening protocols into school-based and community-led health systems allows for the stratification of high-risk individuals.

Adolescents identified with elevated SD, marked by severe rumination or perceived low social support, should be funneled into low-intensity, cost-effective, and scalable preventative frameworks, such as internet-delivered Cognitive Behavioral Therapy (iCBT) or school-led resilience-building groups [33, 34]. Furthermore, our identified neurobiological and cognitive targets suggest that preventative psychiatric nursing interventions should specifically focus on disrupting ruminative loops and enhancing behavioral activation to actively stimulate the under-activated reward circuitry [35]. Intercepting depression during this subclinical, neuroplastically flexible window offers a unique, cost-effective opportunity to alter the life-course trajectory of high-risk youth and alleviate the global healthcare burden of affective disorders.

4.5. Limitations and Future Directions

Despite its comprehensive scope, several limitations of this meta-analysis warrant caution. First, a high level of overall inter-study heterogeneity (I^2 = 99.1%) was captured in our primary prevalence model, a common challenge in large-scale psychiatric epidemiology driven by diverse global sampling strategies and socio-cultural variations. Second, our longitudinal synthesis was constrained by a relatively small number of cohort studies (n = 5) and varying lengths of follow-up, which limited our capacity to execute a quantitative meta-regression on precise temporal predictors of conversion. Third, our literature search was restricted to publications in English and Chinese, potentially introducing a degree of linguistic bias.

Future primary research should prioritize the execution of large-scale, multi-center prospective cohorts utilizing standardized, consensus-compliant diagnostic tools and synchronized follow-up intervals. Additionally, future studies should actively integrate multi-modal designs—combining digital phenotyping like smartphone passive sensing, genetic risk scores, and functional neuroimaging—to construct high-precision, machine-learning-driven early-warning algorithms for clinical conversion.

5. Conclusion

5.1 Synthesis of Epidemiological Burden and Clinical Trajectories

This systematic review and meta-analysis underscores the substantial global epidemiological burden of adolescent subthreshold depression (SD), firmly establishing it not as a transient affective fluctuation, but as a profoundly prognostic, unstable prodromal phenotype. Our findings demonstrate that approximately 19% of adolescents worldwide are affected by SD—a pooled prevalence that markedly eclipses that of full-syndrome Major Depressive Disorder (MDD). The robust association between baseline SD and a fourfold increased risk of diagnostic conversion (OR = 4.01), coupled with a 13-year cumulative incidence of 34%, identifies this subclinical entity as a high-stakes psychiatric condition.

To synthesize these multifaceted findings, we propose a comprehensive conceptual framework of the adolescent SD clinical trajectory (Fig. 5). This evolutionary model delineates how baseline subclinical symptoms transition to syndromal MDD, a progression crucially mediated by a precarious interplay of biological substrates like frontostriatal reward-circuitry hypoactivation [36], cognitive vulnerabilities such as persistent rumination [37, 38], and socio-environmental stressors [39]. By mapping out the heterogeneous pathways of SD—encompassing symptom persistence, spontaneous remission, and formal diagnostic transition—this framework provides a rigorous theoretical scaffolding for shifting the pediatric mental health paradigm away from reactive, crisis-oriented diagnostics toward proactive, early-stage surveillance during this sensitive neurodevelopmental window.

5.2. Determinants of Vulnerability and Methodological Heterogeneity

A pivotal contribution of this study is the quantification of a universal, sex-based vulnerability, with female adolescents exhibiting a 63% higher risk of experiencing SD (OR = 1.63). The absolute across-study homogeneity captured for this effect size (I^2 = 0%) strongly implies that the well-documented gender gap in clinical depression originates fundamentally at the subclinical level, driven by the intersection of pubertal hormonal shifts [40], self-referential cognitive biases [25], and interpersonal sensitivities [41]. Furthermore, our analysis identified assessment modality as a primary driver of inter-study methodological heterogeneity. The prominent discrepancy between self-report estimates (22%) and clinician-rated interview outcomes (14%) underscores an urgent clinical need for standardized diagnostic protocols to reliably distinguish acute [42], transient psychological distress from stable, high-risk prodromal states.

5.3. Translational Implications and Future Horizons

From the perspectives of global public health and preventive psychiatric nursing, these findings provide a compelling empirical rationale for integrating systematic, gender-sensitive SD screening into routine school-based and primary care frameworks. Stratifying at-risk youth based on identifiable cognitive profiles like severe rumination [43] or perceived deficits in social support allows for the deployment of scalable [44], low-intensity "Stepped Care" interventions—such as digital Cognitive Behavioral Therapy or behavioral activation—to disrupt the developmental trajectory toward clinical depression before full diagnostic thresholds are crossed.

Although the high overall heterogeneity and the relative scarcity of long-term prospective cohorts warrant caution, this study establishes a clear baseline for future research. To optimize precision preventive strategies, future primary investigations must prioritize large-scale, multi-center prospective designs utilizing gold-standard structured interviews, while simultaneously exploring the neurobiological and psychological resilience factors among the majority of adolescents with SD who do not progress to MDD. Ultimately, prioritizing the early identification and evidence-based management of adolescent SD offers a vital, cost-effective opportunity to fundamentally alter long-term disease trajectories and alleviate the escalating global burden of affective disorders.

Declarations

Conflicts of Interest Statement

All authors declare that there are no conflicts of interest that could potentially affect the objectivity of this study during the research conduct and manuscript publication process, including but not limited to financial interests, personal relationships, intellectual property rights, and other relevant aspects.

Author Contributions

All authors contributed to the conception and design of this study. Shengqing Li and Jianjiao Yu contributed equally to this work and share first authorship. S. Li and J.Yu led the literature search, data analysis, and interpretation, and drafted the original manuscript. X. Li, D. Cui, A. He, J. Wang, H. Wang participated in the literature screening, critical revision of the manuscript for important intellectual content, and refinement of the conceptual analysis framework. J. Huang and Y. Fu, the corresponding author, supervised the entire research process, provided critical guidance on the manuscript structure and academic content, and revised the manuscript for final submission. All authors have read and critically reviewed the manuscript, approved the final version to be published, and agree to be accountable for all aspects of the work, including the accuracy and integrity of all parts of the study and manuscript.

Ethics approval and consent to participate

As this study is a systematic review and meta-analysis based on published literature, ethics approval and consent to participate were not required.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

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Figures

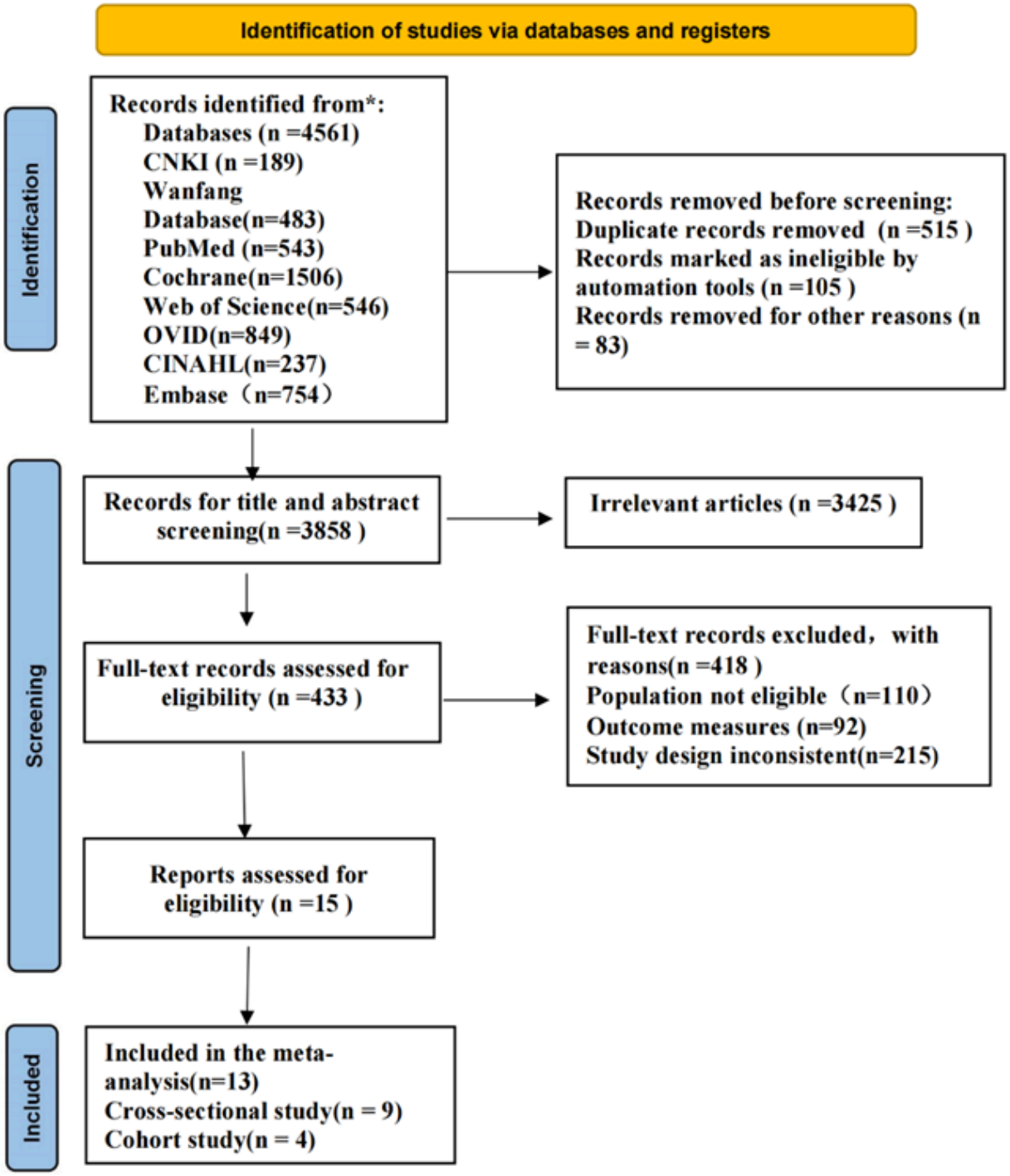


Figure 1

PRISMA flow diagram of study selection

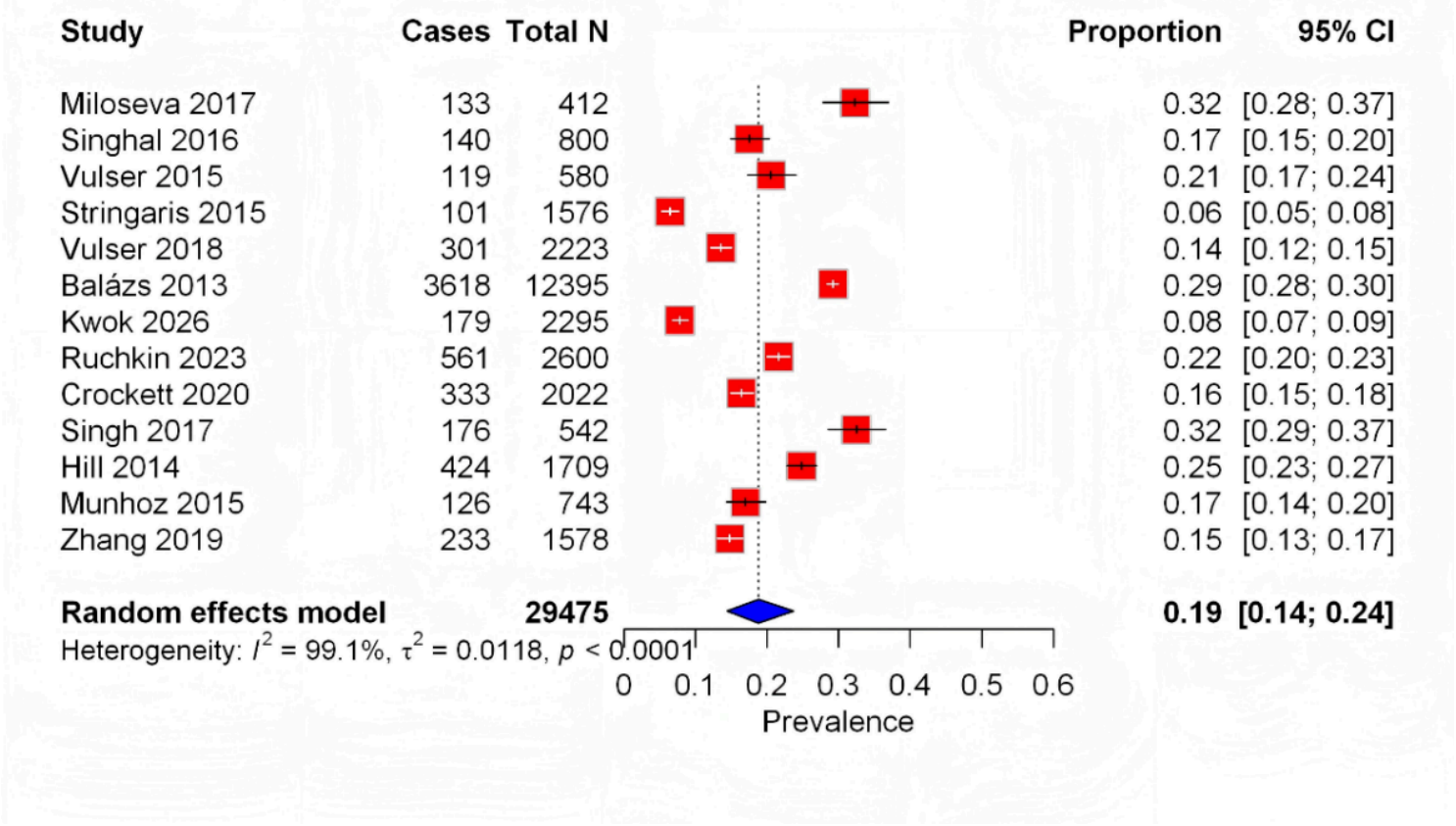


Figure 2

Forest plot of the global pooled prevalence of adolescent subthreshold depression (SD)

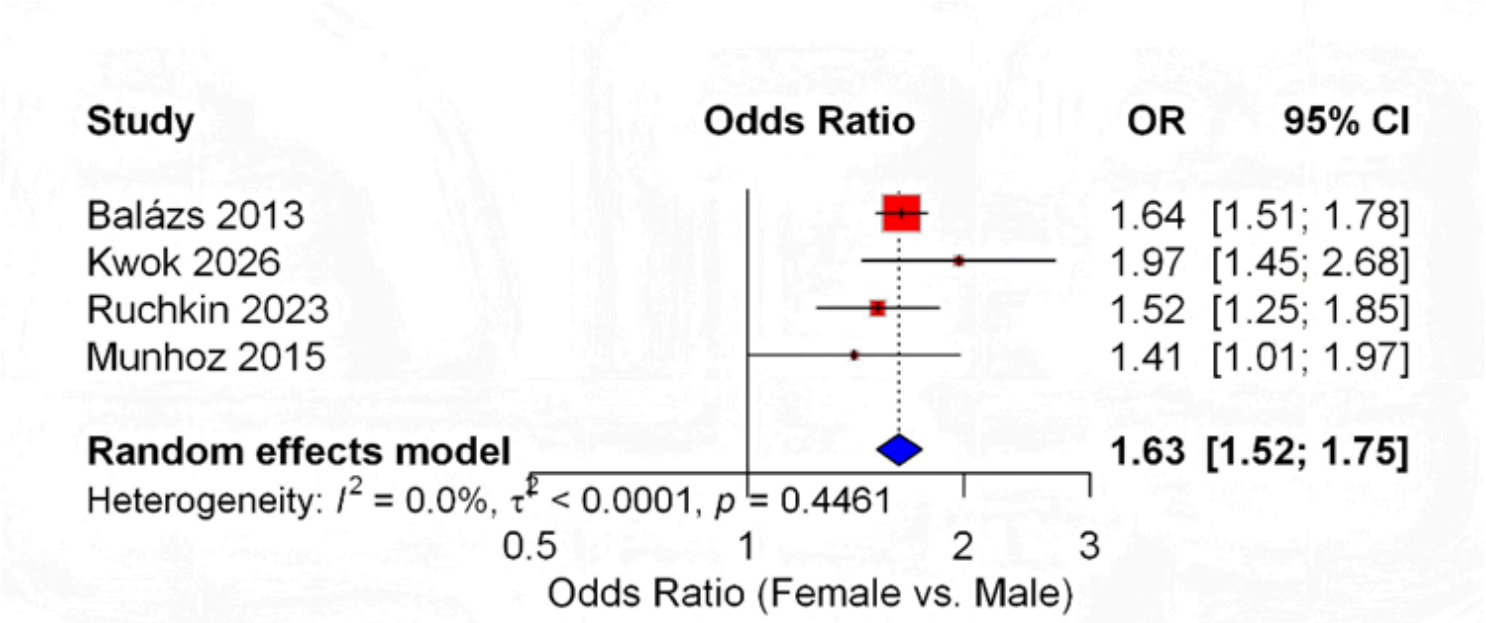


Figure 3

Forest plot of gender as a risk factor for adolescent SD (female vs. male)

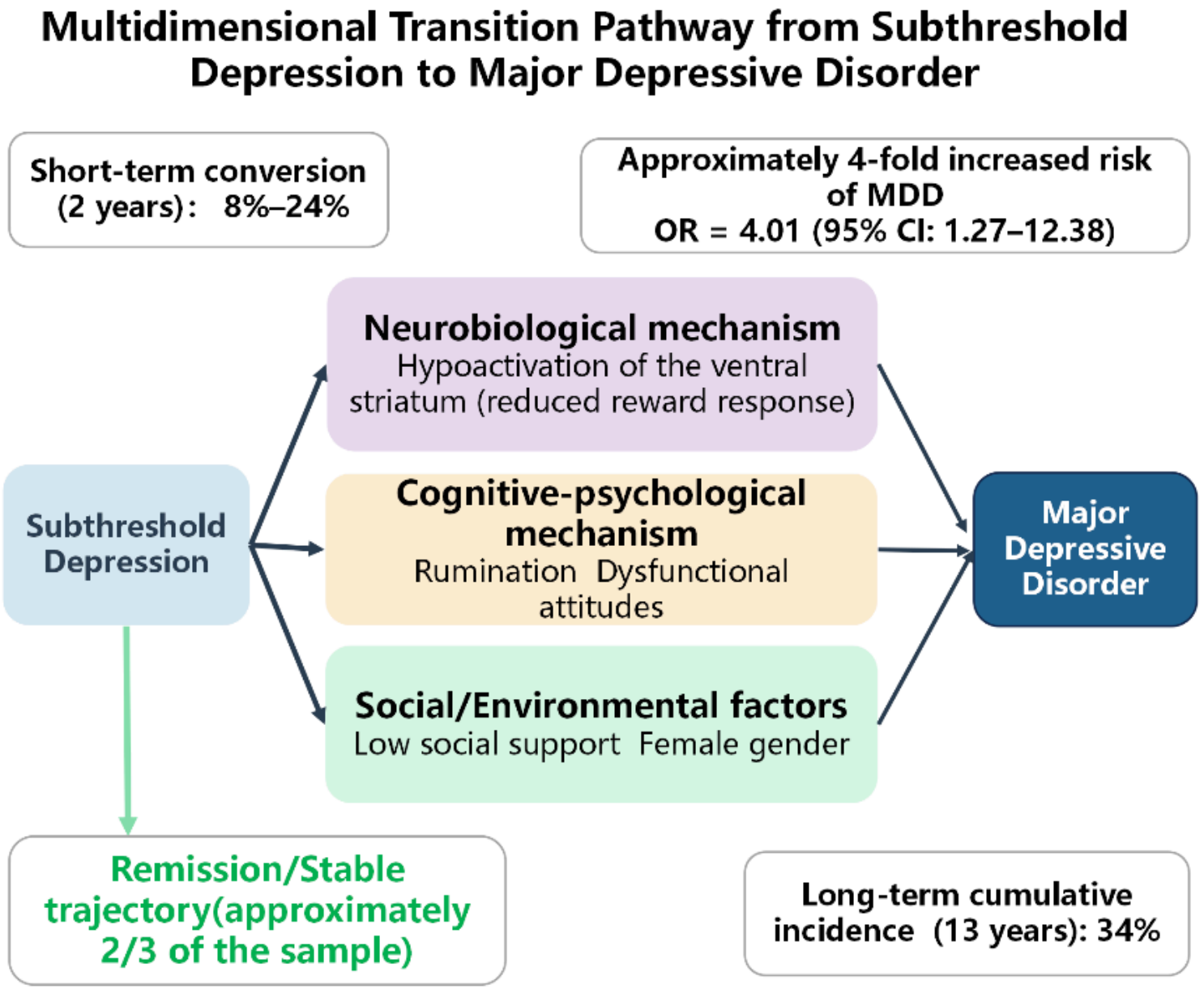


Figure 4

Meta-analysis of MDD Conversion Risk

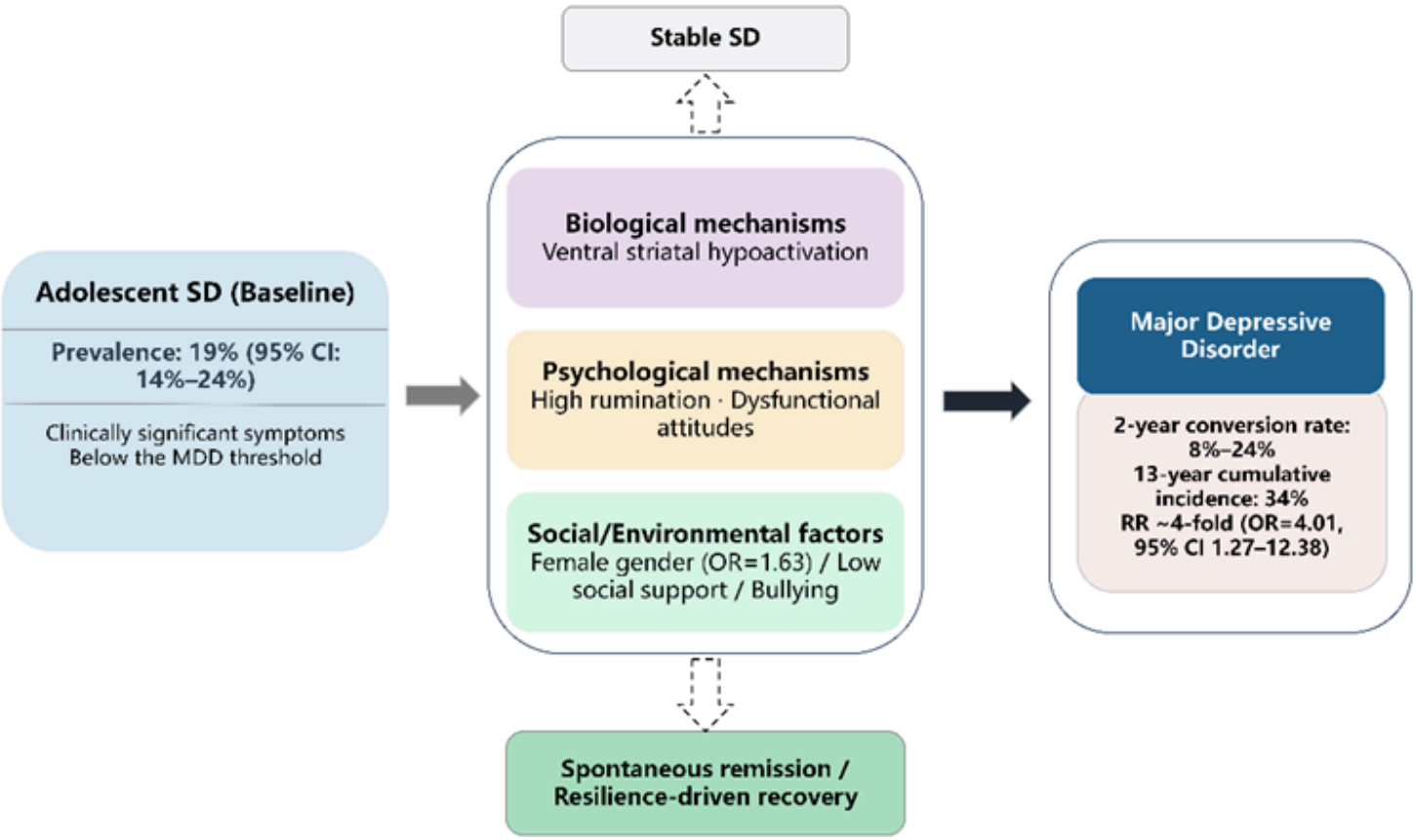


Figure 5

Clinical Trajectory Map

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile2TableS2.SelectedCharacteristicsofIncludedStudiesonSubthresholdDepression.xlsx
- Additionalfiles.docx