Machine Learning Approaches to Profiling At-Risk Youth

Multi-Level Insights from Personal, Family, and Peer Contexts

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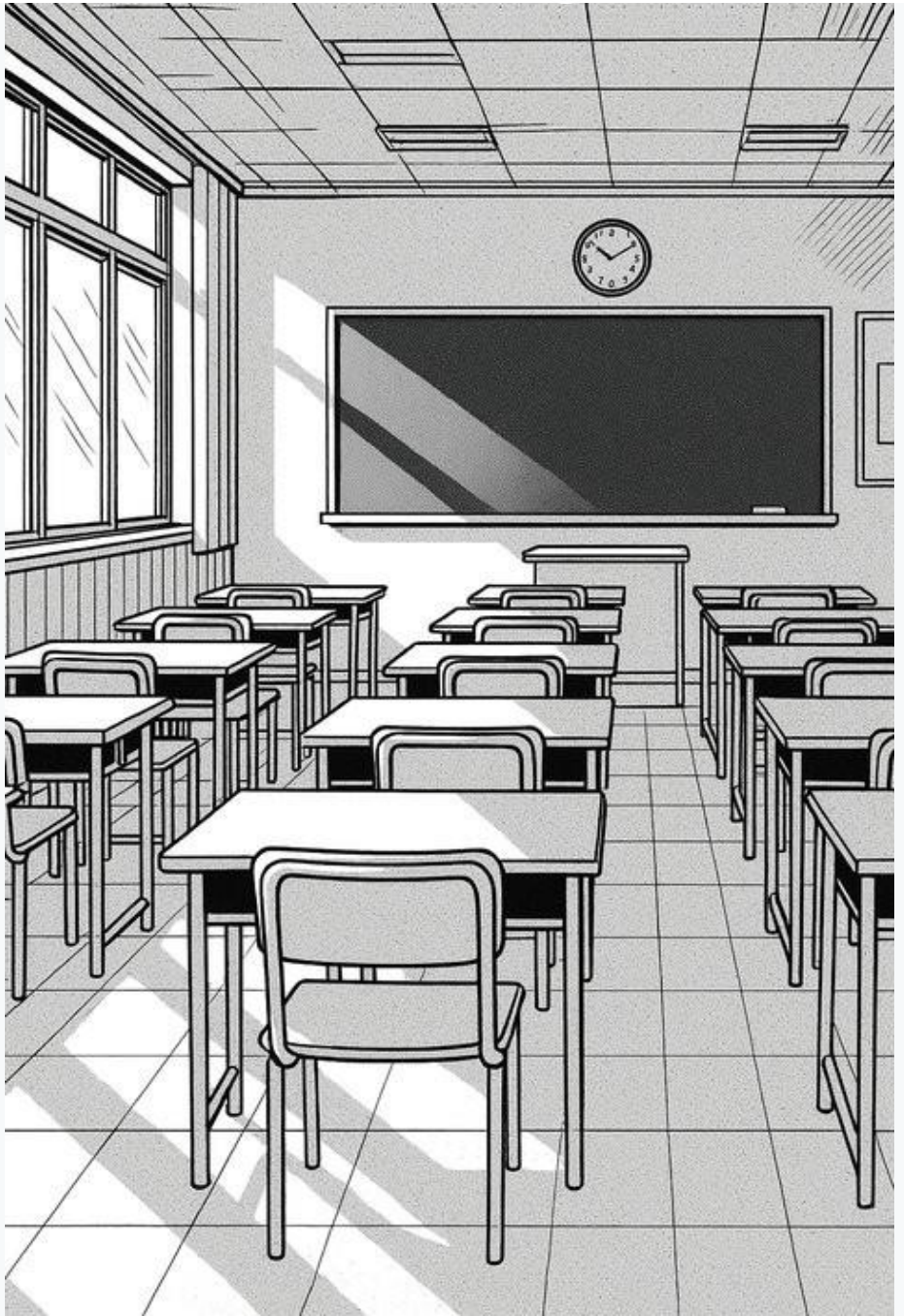


Youth Mental Health Issues Are Widespread and Growing

Global Impact

According to the World Health Organization:

15% of adolescents

aged 10 to 19 experience a mental disorder

*That's **one in seven** young people*

Severity

- Suicide is the third leading cause of death among young people aged 15 to 24
- This is not a small issue. This is not only a health problem

This is a life-and-death issue

Regional Examples

- In China: **20%** of high school students report moderate to severe symptoms of depression
- In Japan: Youth suicide is the **leading cause** of death among adolescents

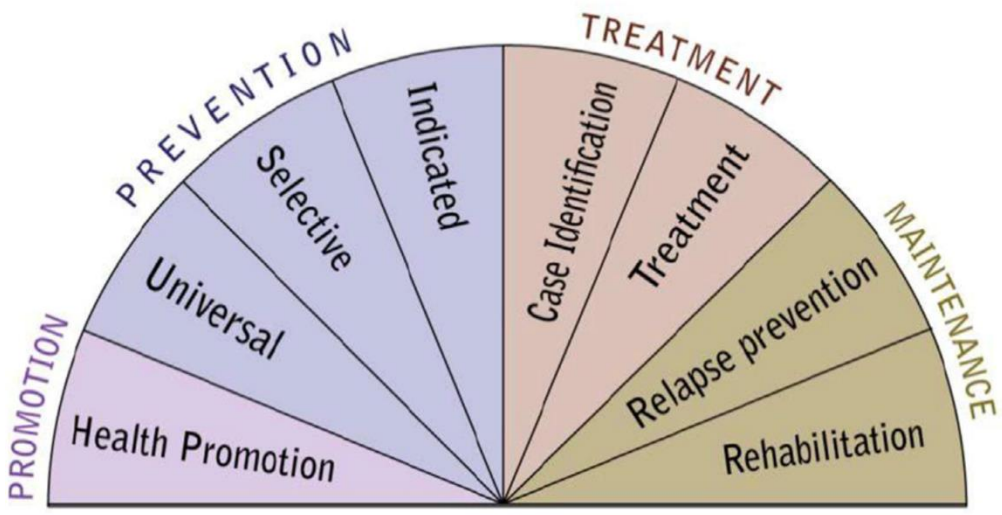
The Dangerous Silence

- Many young people do not talk about their struggles
- They hide their feelings
- They pretend to be fine

When we cannot see the pain, we cannot act in time

Mental health challenges are global. The silence is dangerous.

The Earlier We Act, the More Lives We Can Protect



Intervention Spectrum Model.
From Institute of Medicine. (2009).

Mental health is a medical issue?

Youth mental health is not only a medical issue. It is also a social issue, an educational issue, and a community issue. Families, schools, peers, communities—all play a role.

What can we do?

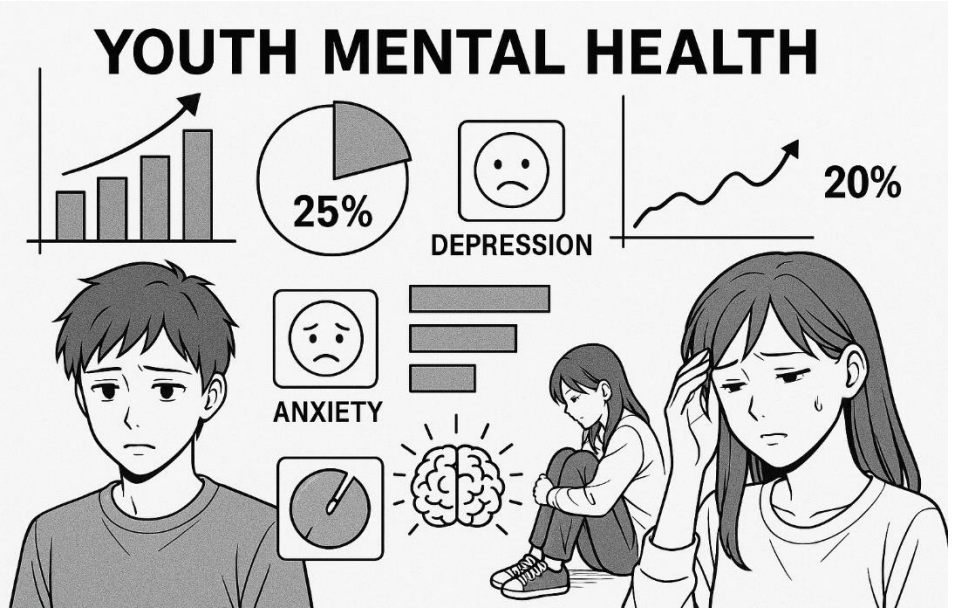
We must act early. If we can see the signs earlier, we can take action earlier. And if we act earlier, we can protect more young people, and even save lives.

But here comes the challenge:

How do we see the signs early? How do we know who is vulnerable? What tools do we have to help us? And are those tools good enough?

Contents & Presentation Structure

A comprehensive overview of youth mental health challenges, the development of the Psychopathological Vulnerability Index (PVI), and its implications for early intervention



- Youth Mental Health Crisis
- The Measurement Challenge
- A New Paradigm
- Instrument Development
- The Findings
- Turning Research into Action

Measurement Tools Often Miss the Mark

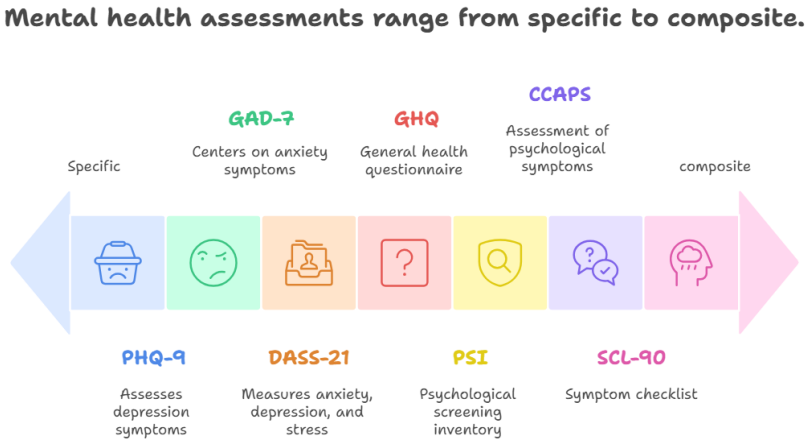
Specific Instruments (e.g., PHQ-9, GAD-7)

- Focus on single disorder (e.g., depression, anxiety).
  - The PHQ-9 focuses only on depression.
  - The GAD-7 focuses only on anxiety.

- These are helpful, but they give us only one piece of the picture.

Composite Instruments (e.g., SCL-90, CCAPS)

- Broader scope (e.g., somatic symptoms, social dysfunction).
  - The SCL-90 has many items and covers many areas, but it is long and outdated.
  - It was designed decades ago, using methods from **Classical Test Theory**.
  - It does not always tell us clearly what the scores mean.
  - It does not always ensure that items are fair across different groups.



This creates a gap

- We need tools that are specific enough to be useful.
- We need tools that are broad enough to capture the complexity of youth mental health.
- We need tools that are short, simple, and reliable.

Continuous, Not Discrete: The New Paradigm for Psychopathology

Discrete

DSM-5 & ICD-11 Models

Categorical Classification

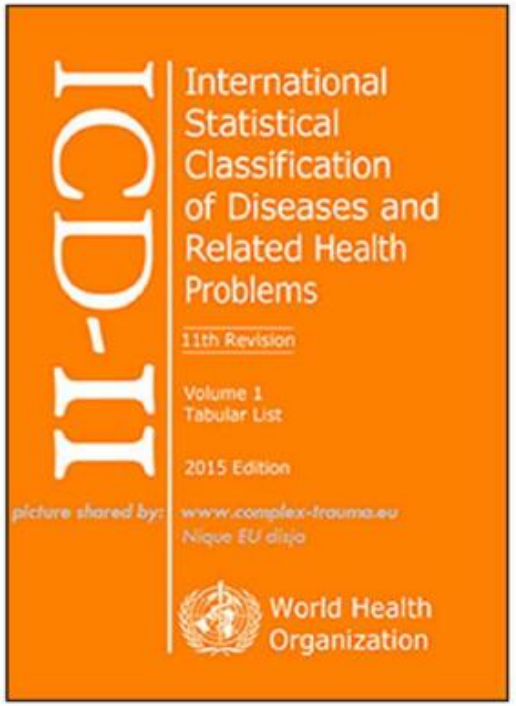
challenged by high comorbidity rates and overlapping symptoms across different diagnoses.

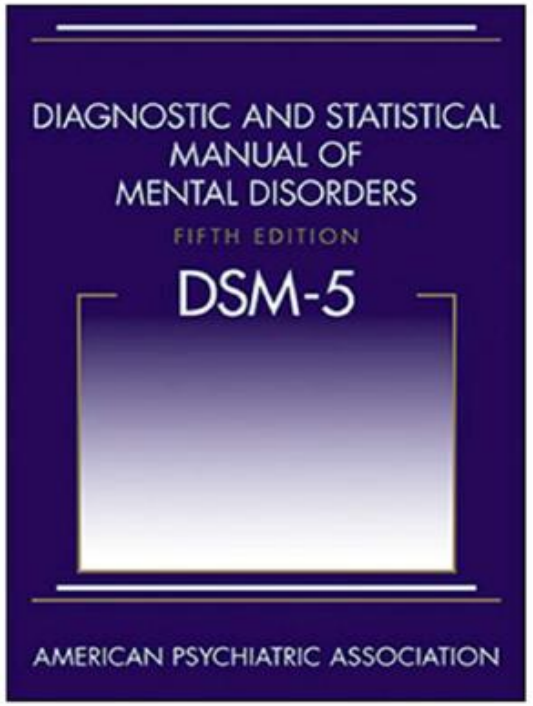
Continuous

P-Factor Model & RDoC

Dimensional Approaches

offered a more nuanced understanding of mental health and capturing the reality of symptom overlap.





World Health Organization

AMERICAN PSYCHIATRIC ASSOCIATION

The DSM-5 and ICD-11 are two of the most respected medical manuals in the world for classifying diseases & disorders

Continuous, Not Discrete: The New Paradigm for Psychopathology

Categorical Approach

Divides disorders into separate boxes:

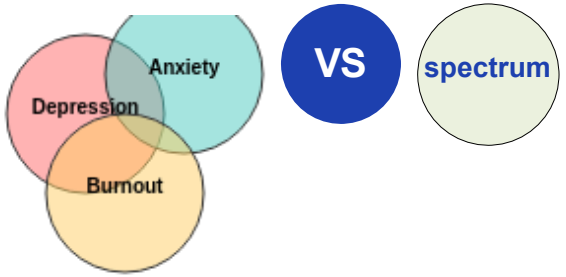
- Depression
- Anxiety
- Burnout
- Internet addiction

Each disorder is like a separate box

Limitations:

- Ignores that many young people live in more than one disorder at the same time
- Difficult to capture subtle variations in symptoms

Like **light switches** — on or off



Why It Matters

Dimensional Approach

Sees problems on a spectrum:

- Symptoms overlap across disorders
- Vulnerability exists before full disorders
- Degree of risk matters

More powerful to detect and predict

Advantages:

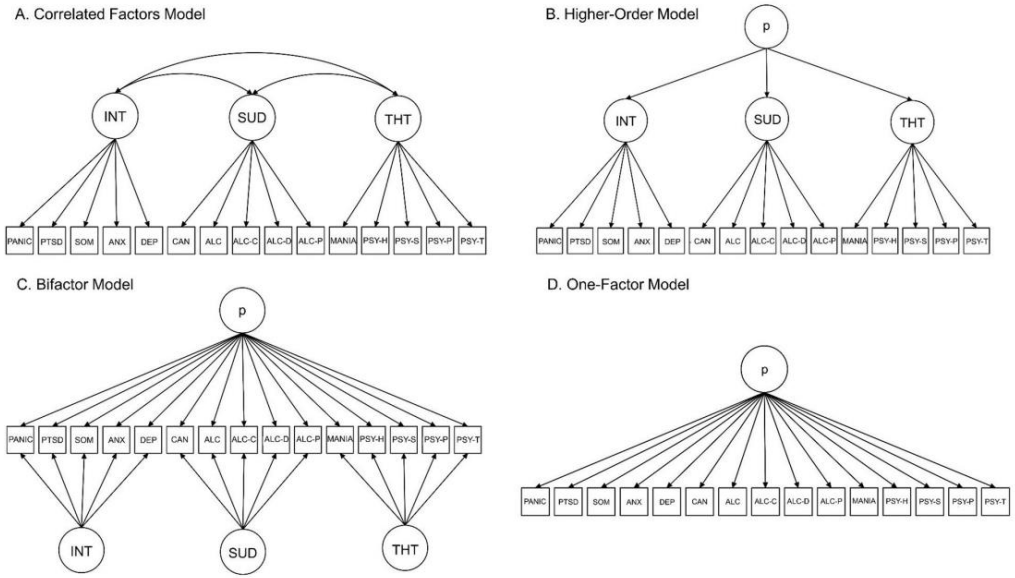
- Captures the **spectrum** of vulnerability
- Measures **severity** across multiple dimensions

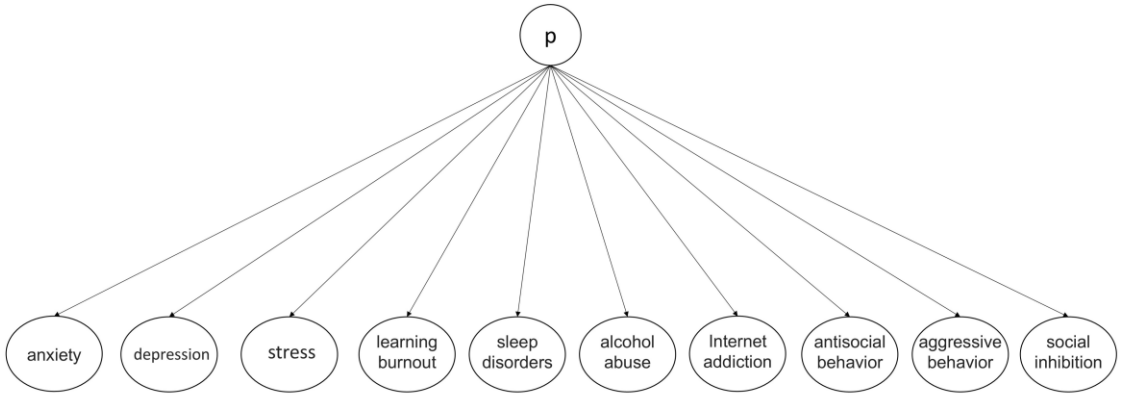
More like **dimmer lights** — shows intensity

If we use dimensional tools, we can see young people earlier, before problems become critical

The General Factor of Psychopathology (P-Factor)

- **Model**: A general factor of psychopathology ("P-Factor") proposes a single underlying dimension of vulnerability (Caspi & Moffitt, 2018).
- **Limitations** of Higher-Order and Bifactor Models in measuring the P-Factor.



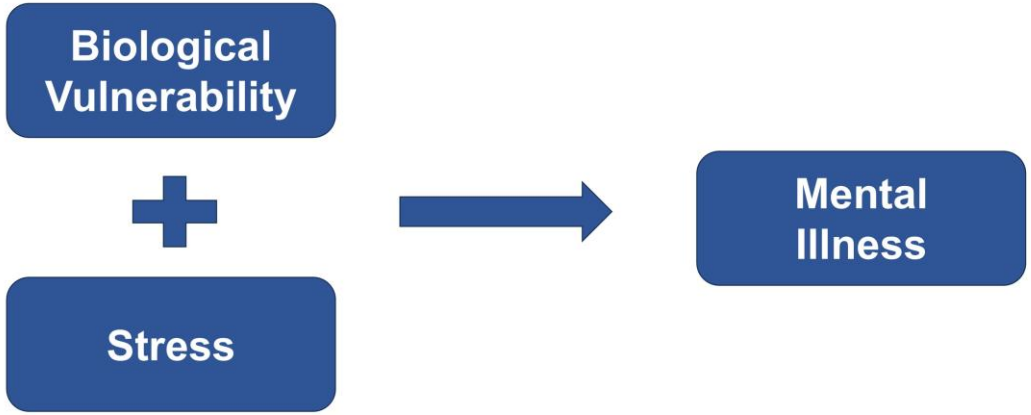


- **Hypothesis**: This factor accounts for the shared variance across diverse mental health symptoms.
- **Implication**: A tool measuring the "P-Factor" could be more efficient and theoretically sound for screening.

The Insight from Vulnerability-Stress Model

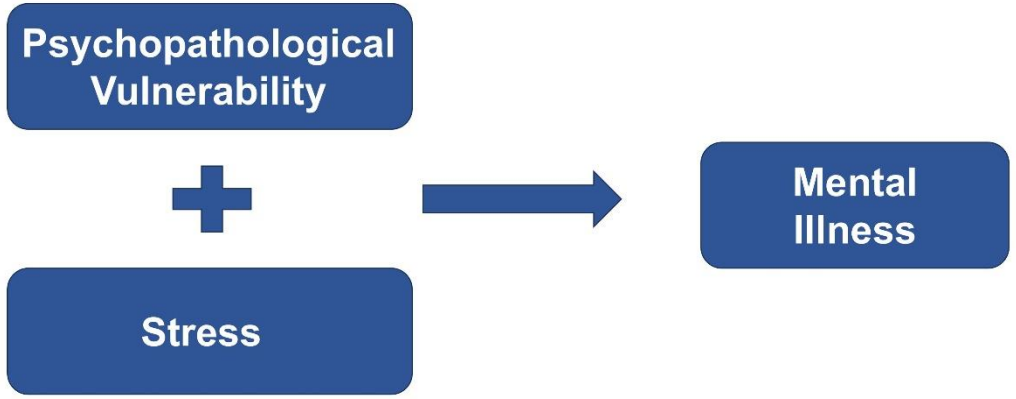
The Vulnerability-Stress Model

- According to the Vulnerability-Stress Model (Zubin & Spring, 1977), **each of us carries a certain level of vulnerability**.
- These vulnerabilities may **come from our genes, from our childhood experiences, from trauma, or from social conditions**.
- Most of the time, these vulnerabilities are **hidden**. They may not cause any visible problems.



P-Factor-Based Vulnerability Model

- If we **measure vulnerability early**, we can provide coping skills, family support, peer support, and community resources. We can reduce the chance of the fire ever starting.
- The P-Factor is like the trunk of a tree, **the shared root of many disorders**.
- The Vulnerability–Stress Model shows how **inner weakness** and **external stress** combine to create problems.



Instrument Development

Aim

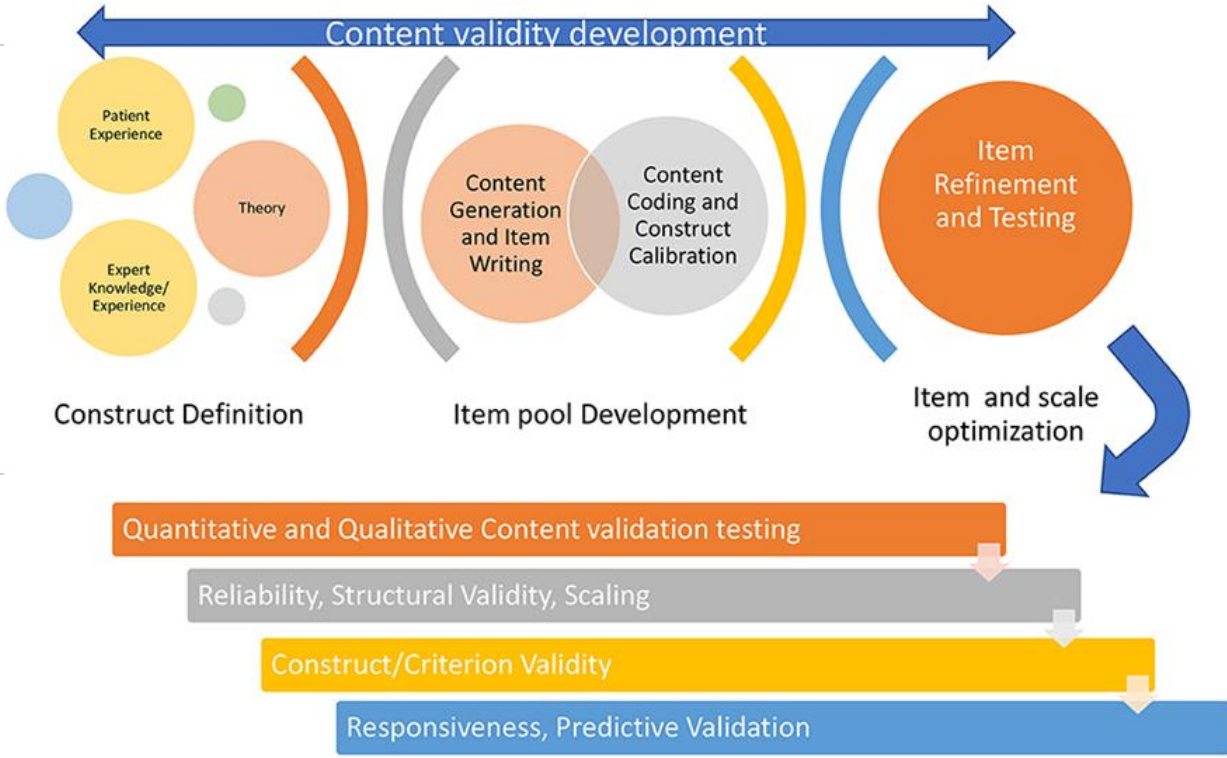
To develop a psychometrically sound, unidimensional index of psychopathological vulnerability (the PVI) for youths.

Three simple but difficult questions:

1. How can we make sure our tool is based on the best scientific evidence?
2. How can we make sure the tool is short, clear, and fair?
3. How can we prove that the tool really works in practice?

A three-phase process:

- ✓ Content Definition & Item Pool Generation
- ✓ Item Selection & Psychometric Evaluation
- ✓ Clinical Utility & Predictive Validation



Defining Content: Domains & Item Pool

Umbrella Review Methodology

- We did what is called an **umbrella review**
- This means we did not just look at one study, or even one review, but at **many review papers together**
- We searched databases like Web of Science using **three groups of keywords**: mental health, systematic review, and youth.
- we selected **24 high-quality** reviews

10 Key Vulnerability Domains

- Anxiety
- Depression
- Stress
- Learning Burnout
- Sleep Disorders
- Alcohol Abuse
- Internet Addiction
- Antisocial Behavior
- Aggressive Behavior
- Social Inhibition

Item Pool Development

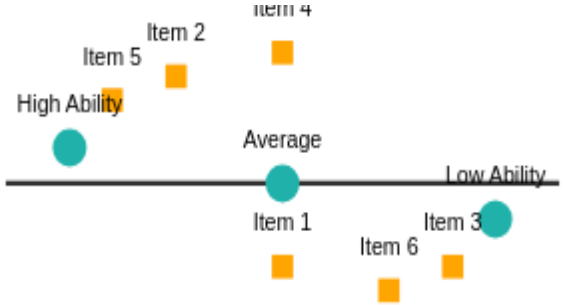
Built a comprehensive item pool of **57 questions** from validated scales across these domains. These formed the candidate items for the final PVI tool.

Mental health issues	Frequency
Anxiety	22
Depression	24
Stress	8
Sleep disorders, sleep quality, sleep problems	8
Attention deficit hyperactivity disorder (ADHD)	6
Posttraumatic stress disorder (PTSD)	6
Social anxiety	5
Disruptive disorder (DD), conduct disorder (CD), oppositional defiant disorder (ODD), aggressive and antisocial behavior	4
Alcohol use	4
Burnout, school burnout, test anxiety, tired	4
Internet addiction	3

Modern Psychometrics: Rasch Model & LCA

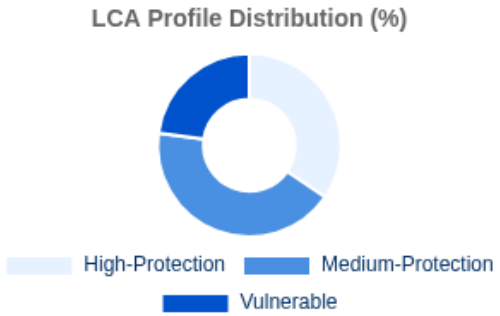
Rasch Model Analysis

- ✓ Traditionally, tests are built using what is called Classical Test Theory.
- ✓ It does not always tell us if an item works equally well for boys and girls.
- ✓ It also does not tell us if items measure just one thing or multiple things.
- ✓ **The Rasch model** asks: does each item fit into one common dimension?



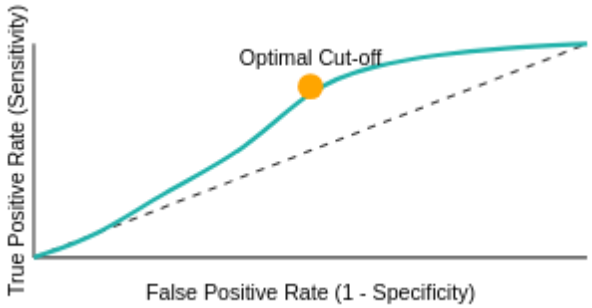
Latent Class Analysis (LCA)

- ✓ This is a statistical method that helps us see if young people can be **grouped into classes** based on their answers.
- ✓ It is like asking: **do these items naturally cluster young people into groups**, like high vulnerability, moderate vulnerability, and low vulnerability?



ROC Analysis

- ✓ we used ROC analysis to helps us find **the best cut-off points** for classification.
- ✓ Creates clear risk category boundaries.



Real-World Validation: Testing the Tool's Effectiveness

Testing in Real Life

Now we come to the third step: testing if the tool works in real life. For this, we compared the PVI to one of the most widely used broad tools, the SCL- 90.

Sample Types

- **Concurrent cases:** Young people who had a diagnosis at the same time as they took the survey.
- **Predictive cases:** Young people who were diagnosed within one year after taking the survey.

Study Design Benefits

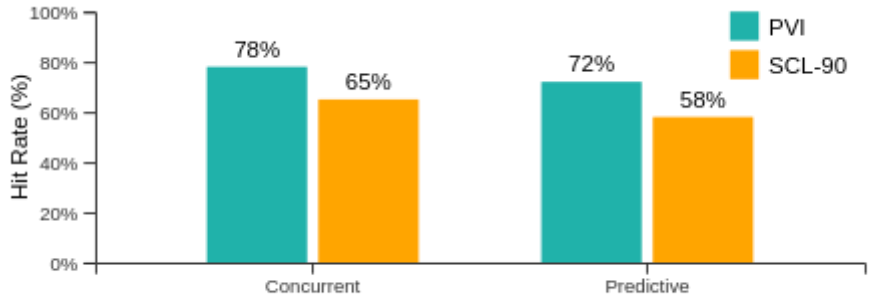
- Can the PVI detect problems now?
- Can the PVI predict problems in the near future?

Key Outcome Measure

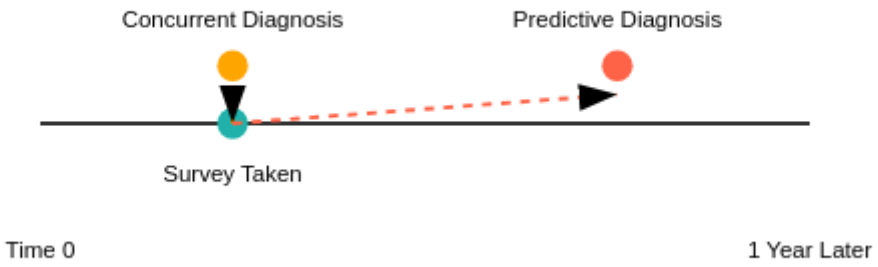
- **Hit Rate:** The percentage of correctly identified vulnerable youths among those who had a diagnosis.

Comparison Visualization

PVI vs. SCL-90 Comparison



Case Types Timeline



Sample & Data Overview

11,224

Valid Study Participants

(from 34 provinces in China)

After **rigorous quality checks** including removing repeated entries, incomplete forms, missing IDs, and failed attention checks, we established a robust nationwide sample for analysis. The average age was 19.6 years, with approximately 56% male participants.

159

Clinical Validation Cases

(99 concurrent + 60 predictive)

To test the tool's effectiveness in real-world settings, we included two specialized **clinical samples** from counseling centers: **99 concurrent cases** (diagnosed at the same time as taking the survey) and **60 predictive cases** (diagnosed within one year after the survey).

PVI: Item Selection Ensures Validity

57→22

Items Selected

(61% reduction)

Iterative Rasch modeling eliminated poorly performing items

Rasch Model

Selection Method

(Dichotomous)

Analysis of item fit statistics (Infit/Outfit MNSQ)

8

Domains Covered

(Core aspects)

Anxiety, Depression, Learning Burnout, Internet Addiction, Alcohol Use, Sleep, Aggression, Social Inhibition

Yes/No

Response Format

(Dichotomous)

Simple format increases accessibility

The PVI is Reliable and Well-Targeted

Scale Design Features:

- ✓ Binary response format (easier for youth)
- ✓ Unidimensional structure confirmed by Rasch

Reliability Metrics:

- ✓Person Separation Reliability = 0.78
- ✓Cronbach's Alpha = 0.84

Targeting:

- ✓mean person location (0.0036 logits)
- ✓The instrument was well-targeted

Dimension		Item content
		Considering your experiences in the past month, respond to the following items by selecting either "Yes" or "No".
Anxiety	a1	I found myself in situations that made me so anxious and I was most relieved when they ended.
	a2	I had a feeling of faintness.
Depression	b2	I felt that I had nothing to look forward to.
Learning burnout	d1	I feel nervous whenever I have an exam.
	d4	I do not have common topics and interests with my classmates.
	d5	I feel that my attitude towards studying is not as good as it used to be.
	d6	I often have trouble sleeping due to things related to my schoolwork.
Internet addiction	e2	I am short of sleep because of the Internet.
	e3	I often neglect my daily obligations (work, school, or family life) because I prefer to spend time on the Internet.
	e4	When I am feeling down, I often go on the Internet.
	e5	I find it difficult to stop using the Internet when I am online.
Alcohol use	f1	I have found that I was not able to stop drinking once I had started.
Sleep disorders	g3	I often have difficulty getting back to sleep after a nocturnal awakening.
	g4	I often wish for more sleep after getting up.
	g5	I am satisfied with my sleep.
Aggressive behavior	i3	Sometimes I fly off the handle for no good reason.
	i5	Other people always seem to get breaks.
Social inhibition	j1	I find it hard to start a conversation.
	j2	I do not find the right things to talk about.
	j3	I have difficulty making contact.
	j4	I often worry that others may disapprove of me.
	j5	I feel very insecure when I do not know another's thoughts.

Item g5 was subject to reverse scoring.

Latent Class Analysis: Risk Grouping

23%

Vulnerable Group

Easily stressed, weaker setback tolerance, unstable emotions.
Urgent support needed.

43%

Medium Protection Group

Generally okay in daily life but break down under high stress.
Long recovery time.

35%

High Protection Group

Resilient, optimistic, emotionally stable. **Quick recovery from setbacks**.

Vulnerable group:

These young people showed strong signals across many of the eight areas. They were easily stressed, had low tolerance for setbacks, and often had unstable emotions. They are the ones who need support urgently.

Medium protection:

These students were generally okay in daily life. But when stress became very high, they broke down. They took a long time to recover. They are fragile under pressure.

High protection group:

These were resilient, optimistic, and strong. They were able to cope with stress, bounce back from setbacks, and maintain stable emotions.

PVI vs.SCL-90: Improved Detection

PVI

Higher hit rates across all cases

41.41%
Concurrent Cases

45.00%
Predictive Cases

45.33%
Overall Performance

The PVI consistently outperforms traditional tools in both current and future risk detection, demonstrating superior accuracy with shorter assessment time.

SCL-90

Traditional assessment baseline

36.36%
Concurrent Cases

36.67%
Predictive Cases

38.67%
Overall Performance

Despite being widely used, the SCL-90 shows lower accuracy in identifying vulnerable youth, particularly in predictive cases where early intervention is most critical.

So Why do These Findings Matter?

the PVI

The Psychopathological Vulnerability Index (PVI) is a tool designed to detect vulnerability in young people **early**, before problems become too serious.

Short and Easy to Use

Compact design makes it simple to administer and score, allowing for quick assessment in various settings.

Reliable Across Groups

Consistent results across different cultural, ethnic, and demographic backgrounds, ensuring broad applicability.

Early Detection

Able to identify vulnerability before problems become clinically significant, enabling early intervention.

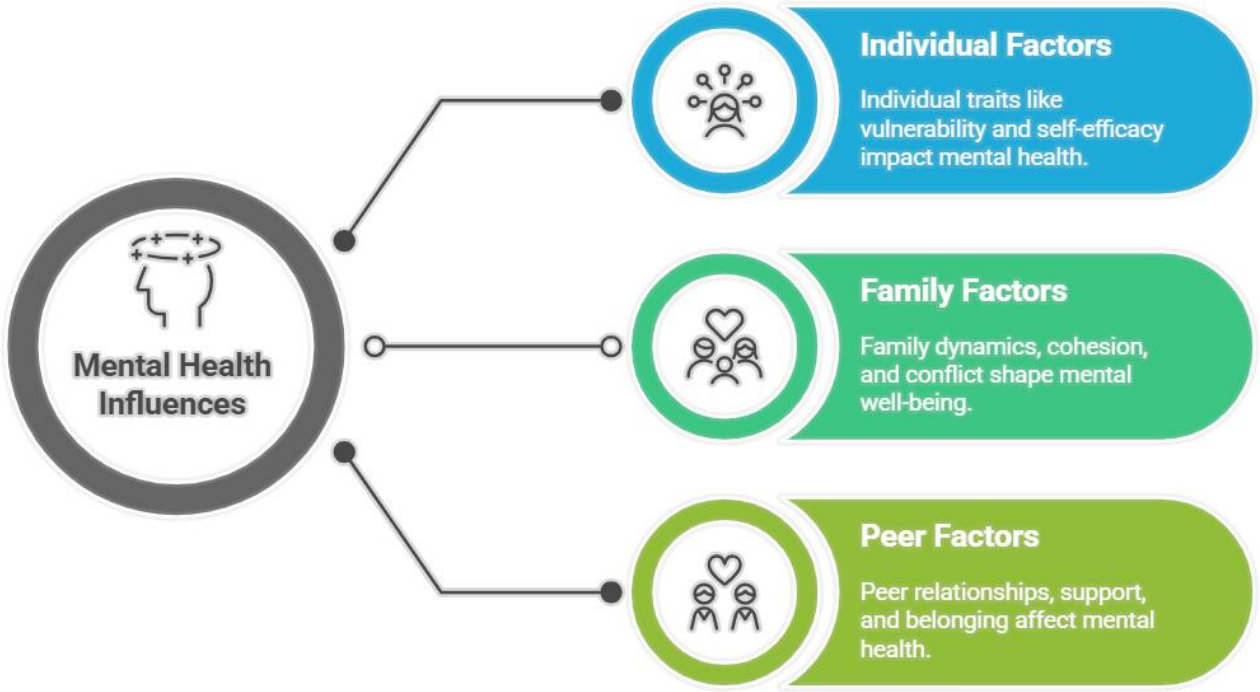
Superior Accuracy

More accurate than older tools in both current cases and future predictions, providing confidence in assessment.

Why it matters: Schools, counselors, and communities can use the PVI to detect risk earlier, with less effort, and with more confidence.

Turning Research into Action: Beyond Individual

Young people develop within multiple contexts. The PVI alone captures only part of the picture. Our comprehensive **Auto-Adaptive Risk Assessment System** integrates individual, family, and peer contexts to provide a more complete understanding of youth vulnerability.



- ✓ They are not only shaped by their **own personal vulnerabilities**.
- ✓ They are also shaped by their **families, their schools, and their peers**.
- ✓ Risks in these areas can **accumulate**.
- ✓ When risks **add up**, the outcomes are worse than a single risk alone.

The Auto-Adaptive Risk Assessment System: A Multi-Level Approach

Individual Vulnerability + **Family Risk** + **Peer Risk** = **Comprehensive Profile**

Step 1: Individual Vulnerability

- Using the PVI to classify students:
  - High-Protection
  - Medium-Protection
  - Vulnerable

Step 2: Family Risk

- Family structure (single-parent, separation)
- Parent education and financial hardship
- Parent-child intimacy and Family conflict

Step 3: Peer Risk

- School climate
- Peer support
- Traditional bullying
- Cyberbullying

How the System Works in Practice?

Low vulnerability, supportive family, strong peer network = Regular monitoring

Moderate vulnerability, some family conflict, poor peer support = Targeted group programs

High vulnerability, high family risk, bullying victimization = Immediate professional referral

The system adapts next steps to each student's unique profile

Personalized Intervention Based on Risk Profile

Low Vulnerability

Individual: Low PVI score

Family: Supportive environment

Peer: Strong network

Recommended:

Regular monitoring only

Moderate Vulnerability

Individual: Medium PVI score

Family: Some conflict

Peer: Poor support

Recommended:

Targeted group programs to build resilience

High Vulnerability

Individual: High PVI score

Family: High risk factors

Peer: Bullying victimization

Recommended:

Immediate referral to professional counseling or psychiatric care

Adaptive Intervention Process

Multi-level assessment

Unique risk profile

Tailored intervention

The system adapts to each student's specific needs

From Risk to Strength: The Future of Youth Mental Health Assessment

Up to now, our work has focused mainly on problems—on **vulnerability**, risks, and detecting early signs of mental health difficulties. This is important, but it is **not enough**.

PVI + **SDI** = **Two-Dimensional Framework**

Why Measure Strengths?

- Young people are not only vulnerable
- They also have **strengths** inside themselves
- They have resources in their **families** and **communities**
- If we focus only on risks, we miss half of the picture

The Strength Development Index (SDI)

Our next step is to develop a new tool that measures **protective factors** across several domains:

Personal	Family	Peer
Optimism, emotional regulation, perseverance	Warmth, trust, communication	Friendship, belonging, cooperation

Our vision: to build systems that are not only about detecting problems, but also about fostering growth, resilience, and well-being.

From Risk to Strength: The Future of Youth Mental Health Assessment

Current Limitation

- Focusing only on risks misses youth **strengths and resilience factors**

Future Development

- New **Strength Development Index (SDI)** will measure protective factors across personal, family, and peer domains
- Creating a **two-dimensional framework**: PVI identifies vulnerability while SDI highlights strengths

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Early Detection Leads to Early Action

Early Detection

If we can **detect early**, we can act early.

- Using tools like the PVI
- Looking for subtle signs
- Taking action before problems escalate

Early Action

If we act early, we can **save lives**.

- Implementing personalized interventions
- Providing support networks
- Using the multi-level approach

Strength-Based

Measuring **strengths** to build resilience.

- Developing the SDI
- Building protective factors
- Helping youth grow stronger

Our Vision: To build systems that detect problems early and foster growth, resilience, and well-being.

Together, we can make a difference in youth mental health.


Thank You!