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Research Article

Boolean Algebra (Mathematical Logic) for Differential Diagnosis of Psychiatric Disorders

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Abstract

The endemic zoonotic disease fascioliasis is very common in eastern Uttar Pradesh. The essential oils play an important role in controlling snail population. Current research shows that essential oils from various Mentha piperata and Mentha spicata plant materials are effective as phytomolluscicides against the snail vector *Lymnaea acuminata.* Essential oils from various plant materials of Mentha piperata and Mentha spicata are extracted by traditional and non-traditional methods such as solvent extraction (SE) and hydrodistillation (HD). From the results section, it is clear that Mentha piperata and Mentha spicata essential oil have strong molluscicidal activity (24-h LC50 values are 4.01 and 4.50 respectively, especially against the snail vector Lymnaea acuminata). The results of this study clearly showed that essential oils cause great harm when applied to snail carriers. The aim of this study is to establish the molluscicidal effect of essential oils of different plant materials of Lantana indica against the snail vector *Lymnaea acuminata.*

Kew Words: solvent extraction; hydrodistillation; phytomolluscicides

Introduction

Psychiatric diagnosis depends on structured criteria that can be ambiguous or overlapping[5]. Boolean algebra replaces ambiguous prose with variables and mathematical operators—AND (∧), OR (∨), NOT (¬), IMPLIES (⇒), and DEFINED-AS (:=)—yielding truth-functional rules that are auditable and implementable in clinical decision support[1-4]. Mathematical logic (Boolean algebra) has long been proposed to clarify diagnostic reasoning in psychiatry, linking structured criteria to computational decision support. [5-9] By making necessary and sufficient conditions explicit and encoding exclusions directly, Boolean algebra enables reproducible, interpretable diagnostic reasoning. This manuscript adapts those principles to common psychiatric syndromes while preserving clinician interpretability (see Table 1 for variable definitions and Table 2 for diagnostic schemata). Objective of this article is to demonstrate the usefulness of Boolean algebra for differential diagnosis by a few selected examples.

Materials and Methods

We represent each diagnostic element (symptom, duration, exclusion, impairment) as a binary variable that can be True (1) or False (0). Diagnostic rules are formalized as Boolean expressions. Unless otherwise stated, conjunction (AND, ∧) is the default operator for combining required conditions. Duration thresholds and course specifiers are encoded as explicit variables. Exclusion criteria are encoded via negation (NOT, ¬). Where diagnostic hierarchy is required, implication (⇒) suppresses subordinate diagnoses. Variable definitions appear in Table 1, diagnostic schemata in Table 2, and a worked example of mathematical evaluation appears in Appendix B.

Variable	Meaning	Clinical Example / Threshold
$D_{moo}d$	Depressive mood and symptom cluster	≥5 depressive symptoms in the same 2-week period with depressed mood or anhedonia
B↑	Elevated or irritable mood (mania)	≥1 week of manic symptoms (or any duration if hospitalized)
H	History of hypomania	≥4 days of elevated/irritable mood with ≥3 hypomanic symptoms
$S_{sh}cz$	Schizophrenia core symptoms	Hallucinations, delusions, or disorganized speech (Criterion A) ≥1 month
M_{moo}d-dominant	Mood-dominant course	Mood episodes occupy majority of illness duration
$E_{sur}\mathscr{b}_{st}$	Substance/medical exclusion	Symptoms better explained by substance or another medical condition
I	Impairment or distress	Clinically significant distress or functional impairment

Legend (Table 1): Binary variables take values 1 = True and 0 = False. Unless explicitly noted, diagnostic criteria are combined using the AND (∧) operator

Table 1: Core Boolean Variables for Psychiatric Diagnosis[14]

Diagnosis	Boolean Definition (:=)
Major Depressive Disorder (MDD)	MDD := $D_{mood} \wedge T_2w \wedge I \wedge \neg B\uparrow \wedge \neg E_{su}\mathscr{b}_{st}$
Bipolar I Disorder (BD-I)	BD-I := $B\uparrow \wedge I \wedge \neg E_{su}\mathscr{b}_{st}$
Obsessive–Compulsive Disorder (OCD)	OCD := $(O \vee C) \wedge T_1h/day \wedge I \wedge \neg E_{su}\mathscr{b}_{st}$
Post-Traumatic Stress Disorder (PTSD	PTSD := $E \wedge B \wedge A \wedge N \wedge D \wedge T>1m \wedge I \wedge \neg E_{su}\mathscr{b}_{st}$

Table 2: Diagnostic Schemata as Boolean Expressions

Legend (Table 2): Operators—∧ = AND (all listed conditions must be true); ∨ = OR (at least one true); ¬ = NOT (exclusion); := = defined as. See Appendix A for full symbol glossary.

Symbol	Name	Mathematical Definition	Clinical Interpretation
∧	AND	1 if both operands are true	All criteria must be met simultaneously
∨	OR	1 if at least one operand is true	Any one of several alternative criteria may be met
¬	NOT (negation)	1 if operand is false	Explicit exclusion (e.g., not substance-induced)
⇒	Implies	If first statement has the value 1, second must also be 1	Hierarchical dependency
:=	Defined as	Left term is defined by right expression	Mathematical definition of diagnosis

Appendix A: Glossary of Mathematical Symbols

D_{mood}	B↑	H	$E_{su}\mathscr{b}_{st}$	I	Diagnosis Output
1	0	0	0	1	Major Depressive Disorder (MDD)
1	0	1	0	1	Bipolar II Disorder (BD-II)
0	1	any	0	1	Bipolar I Disorder (BD-I)
any	any	any	1	any	No Diagnosis (Excluded Because of Substance Effect)

Appendix B: Truth-Table Example

Legend (Appendix B):

1 = True (criterion present); 0 = False (criterion absent); any = either (True or False). Operator used: AND (∧) across each row. All conditions must be tr ue simultaneously for the diagnosis to evaluate True; exclusions apply via NOT (¬).

Discussion

Encoding psychiatric diagnostic criteria with Boolean algebra yields transparent, auditable rules (see Table 2 and Appendix B). Conjunction (AND) clarifies necessary co-occurrence of key features; negation (NOT) enforces exclusions; disjunction (OR) models alternatives; implication expresses hierarchy when needed. These findings align with computational psychiatry models emphasizing formal reasoning, causality, and transparency in clinical systems. [10-14] This formalization supports decision support, inter-rater consistency, and validation against gold-standard interviews. Limitations include measurement error, threshold artifacts, and comorbidity requiring hierarchical post-processing. Future work may integrate probabilistic models while retaining Boolean interpretability.

Conclusion: A few examples have demonstrated that Boolean algebra may be useful as additional tool for differential diagnosis of psychiatric disorders.

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