Comparative Performance of Machine Learning Models for Predicting Extreme Social Withdrawal in Young Adults

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Background

- Extreme Social Withdrawal (ESW), or hikikomori, involves prolonged home confinement and disengagement from education/employment for ≥6 months.
- Originally identified in Japan, ESW is now a global issue, with 2–5% of Korean young adults affected.
- ESW is linked to depression, loneliness, suicidal risk, and impaired functioning, yet many remain undetected due to severe isolation.
- Early identification is crucial, but machine learning approaches for ESW prediction remain limited.

Objectives

- Develop and compare three machine learning models (Logistic Regression, Random Forest, Multilayer Perceptron) for predicting ESW in Korean young adults.
- Identify key sociodemographic and psychosocial factors to inform early detection and intervention strategies.

Methods

- **Data Source & Participants**

· 2022 Seoul Government Survey (N = 5,513; ESW = 794)

· Age 19–39 years (M = 30.1 ± 5.6), 53% female, 64% college educated

· ESW defined as: not attending school/work, staying home, rarely going out for ≥6 months

- **Modeling Approach**

· Data split: 80% training (n = 4,946), 20% test (n = 567)

· Feature selection: elastic-net (L1) and forward selection

· Models: Logistic Regression (LR), Random Forest (RF), Multilayer Perceptron (MLP)

- **Evaluation Metrics**

· AUC, PR-AUC, sensitivity, specificity, PPV, calibration (Brier score)

Results

Performance Comparison of Models

Table 1. Performance of machine learning models on the test set

ML model	AUC	PR-AUC	Sensitivity	Specificity	PPV
LR	0.872	0.645	0.742	0.873	0.496
RF	0.870	0.634	0.742	0.903	0.562
MLP	0.884	0.658	0.793	0.846	0.465

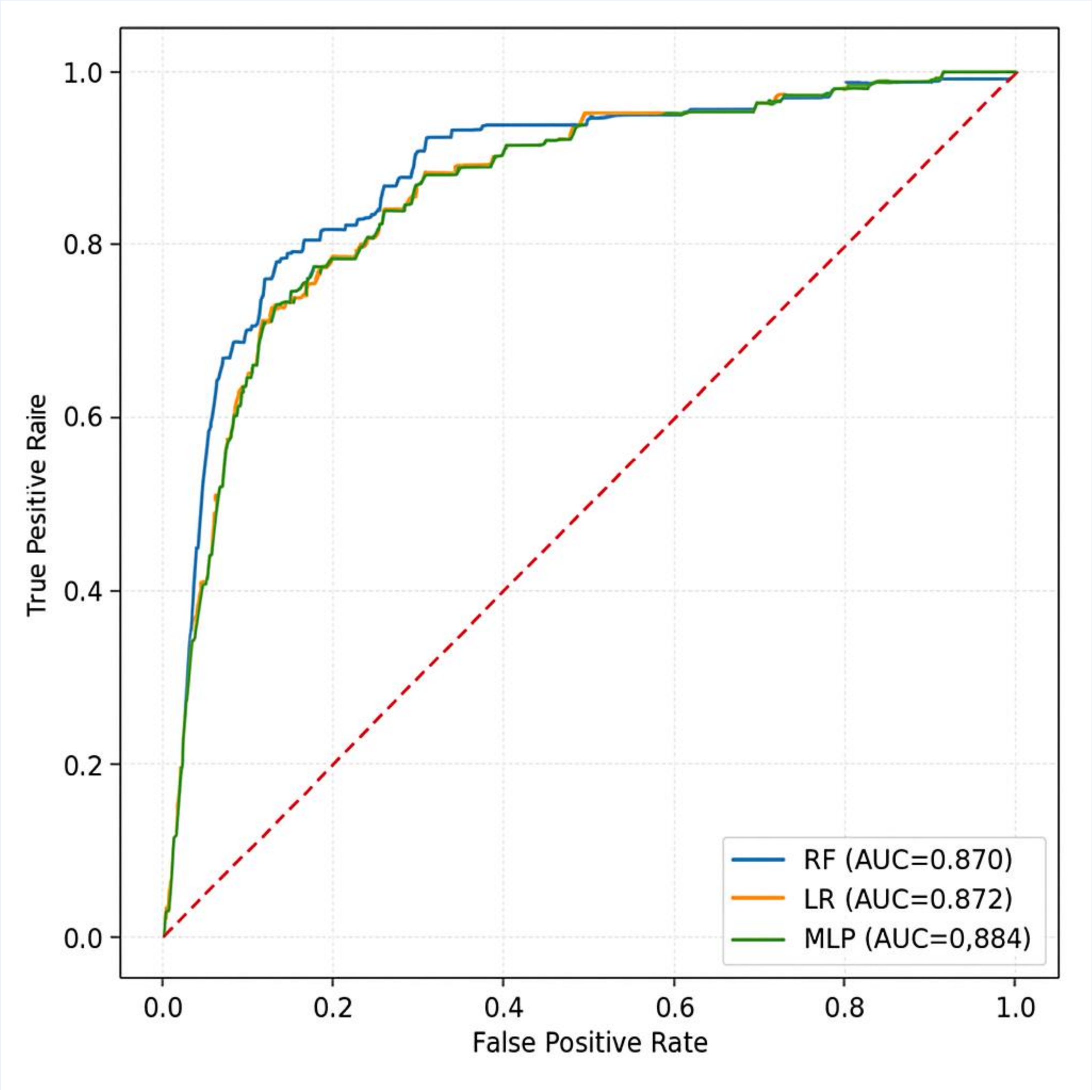

Figure 1. ROC Curves and AUC Values of Five Classification Models

Feature importance and regression analysis

Table 2. feature importance of each variable across machine learning models

	Variables	Permutation importance		
		LR	RF	MLP
1	Intention to escape social withdrawal/isolation	**0.053**	**0.031**	0.037
2	Did not work in the past week	**0.032**	**0.025**	0.025
3	Reason for social withdrawal/isolation: unemployment or job difficulty	**0.022**	**0.025**	**0.056**
4	Full-time occupation	0.019	0.018	**0.048**
5	Tried to escape social withdrawal/isolation	0.011	0.005	0.038
6	Reasons for relapse into social withdrawal/isolation	0.010	0.015	**0.043**
7	Main online activity: chatting or social networking	0.007	0.005	0.008
8	Face-to-face interaction with acquaintances in past month	0.005	0.006	0.027
9	Preferred duration of support from close relations	-0.001	<.001	-0.003
10	Infrequent meals	-0.002	-0.002	0.005

Table 3. Logistic regression estimates for selected features

	Variables	β	SE	Z	OR (95%CI)	*p*
1	Intention to escape social withdrawal/isolation	-0.47	0.05	-10.20	0.62 (0.57, 0.68)	<.001
2	Did not work in the past week	0.40	0.06	7.02	1.49 (1.34, 1.67)	<.001
3	Reason for social withdrawal/isolation: unemployment or job difficulty	0.31	0.04	7.52	1.36 (1.26, 1.48)	<.001
4	Full-time occupation	0.40	0.07	6.06	1.49 (1.31, 1.69)	<.001
5	Tried to escape social withdrawal/isolation	0.23	0.07	3.31	1.26 (1.10, 1.45)	0.001
6	Reasons for relapse into social withdrawal/isolation	0.11	0.04	2.94	1.11 (1.04, 1.19)	0.003
7	Main online activity: chatting or social networking	-0.27	0.07	-4.12	0.76 (0.67, 0.87)	<.001
8	Face-to-face interaction with acquaintances in past month	-0.34	0.06	-5.34	0.71 (0.63, 0.81)	<.001
9	Preferred duration of support from close relations	-0.16	0.06	-2.74	0.85 (0.76, 0.96)	0.006
10	Infrequent meals	0.25	0.05	4.78	1.29 (1.16, 1.43)	<.001

Conclusion

ML models showed strong predictive performance for ESW in a large community cohort. MLP optimized sensitivity, whereas RF provided superior calibration and precision, suggesting different models may serve distinct screening needs. These models may support early detection of at-risk young adults but should be validated in other cohorts before community implementation.

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