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With the widespread use of social networks, researchers have begun investigating its impact on the mental health of the youth. Numerous studies have indicated a link between social media engagement and depression, but establishing causality has remained challenging. Factors such as physical activity, exposure to cyberbullying, and the state of an individual's mental health influencing their social media usage further complicate the issue. This study introduces an innovative approach using a simulation model to examine the relationship between social network usage and adolescent depression allowing the examination of various causation assumptions.

A microsimulation model was developed to investigate the relationship between adolescent social media (SM) use and the onset of depression, anxiety, and suicide attempts. The model consisted of four modules: Demographics, Social Media Consumption, Psychological Disorders, and External Adversities. The demographics module simulated birth cohorts from the 1980s to 2010s, assigning each individual a life expectancy based on French mortality rates. SM consumption patterns, beginning at age 10, encompassed major platforms like Facebook, Instagram, and Snapchat, reflecting real-world usage and its evolution since 2004 (Figure 2). The disorders module hypothesized that while SM can intensify inherent risks, it isn't the sole cause of depression. Factors like childhood adversities, parental psychopathology, and physical activity (PA) were integrated into the model to determine individual depression risks (Table 1). The adversities module utilized French statistics to determine the proportion facing bullying and incorporated physical activity metrics from national surveys.

The baseline simulated distribution (i.e. without social media) is based on the distributions of the different risk factors in the population adjusted so that individuals over the 0.5 cut-off have a depression onset. The distribution is right-shifted by adding Social Media as an additional factor.

To validate the model's accuracy, it was matched against actual French data concerning adversities, SM usage, and physical activity. The simulation involved 10,000 individuals from 1994 to 2012 birth cohorts, and results were derived using Monte Carlo methods. The modeling was done in C++, with analyses performed in SAS (SAS Institute).

Figure 1 shows how SM affected the distribution of the risk of depression onset in teens.

Figure 2 shows the estimated evolution of daily SM use in teen boys and girls since 2004.

Figure 3 to 5 shows the estimated evolution of depression onset, anxiety symptoms and suicide attempts when include the effect of daily SM use increase (no observed data for suicide attempts). For each, the results show an increase in prevalence that follows the increase in daily SM use and is in line with French observed trends.

Parameters	Average
Proportion of adversities	
Parental psychopathology	43.70% ¹
Physical abuse	17.20% ¹
Emotional abuse	34.70% ¹
Sexual abuse	4.40% ¹
Neglect	16.00% ¹
Bullying (Male)	7.90% ²
Bullying (Female)	6.50% ²
Proportion of boys 10-14 with > 60/day of PA	33.70% ³
Proportion of girls 10-14 with > 60/day of PA	20.20% ³
Proportion of boys 15-17 with > 60/day of PA	40.10% ³
Proportion of girls 15-17 with > 60/day of PA	15.70% ³
Annual rate of decrease in the proportion of individuals > 60 min day of physical activity	97.10% ⁴
Proportion of individuals with a reduction in physical activity during COVID19	58.70% ⁵
ln(OR) associated with Depression	
Parental psychopathology	-0.08618 ⁶
Physical abuse	0.127833 ⁶
Emotional abuse	-0.28518 ⁶
Sexual abuse	-0.03922 ⁶
Neglect	-0.08618 ⁶
Bullying	-0.43825 ⁶
2 adversities	0 ⁶
3 adversities	0 ⁶
4+ adversities	0.34249 ⁶
Using 1-2 social media	-0.45108 ⁷
Using 3-4 social media	-0.77011 ⁷
Using > 4 social media	-1.12493 ⁷
Using social media 30-60 min per day	0.051293 ⁷
Using social media 60-120 min per day	-0.27763 ⁷
Using social media > 120 min per day	-0.18232 ⁷
Physical activity < 60 min per day	0.478036 ⁸
Male	0.235722 ⁷
COVID19	-1.4816 ⁹

This study used a novel approach to test the relationship between SM use and well-being, finding that trends in depression matched those observed in France, suggesting SM might be a major factor. The addictive nature of these platforms, especially their algorithmic design, may play a significant role in this epidemic, likening it to other addiction crises.

This study also provides some insight on the difficulty of assessing the consequences of SM use in real life. Figure 1 shows that the impact of SM is modest at the individual level, and only affects the few individuals who have already an elevated baseline risk, while for most individuals SM will not be sufficient to push them to depression. This has a significant impact when conducting observational studies on the association between depression and SM use. It suggests that the study should be both of sufficient size to capture a few individuals at elevated risk (i.e., those between 0.35 and 0.49 in the figure) and should include data on depression risk factors such as adversities or PA. Such studies would be difficult to conduct in real-life, providing an explanation on why robust conclusions on the role of SM in teen depression increase has been elusive.

The results support a probable link between rising SM usage and increased teen depression, emphasizing the urgent need to address this trend to prevent further health and financial consequences.

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Abbreviations: PA: Physical Activity; SM: Social Media