E-learning in formal education under forced conditions using SDT and TAM

Anindita Nandi, Smita Mehendale
1,2 Symbiosis Institute of Management Studies, Symbiosis International (Deemed University), Pune, Maharashtra, India

*Corresponding author:
smita.m@sims.edu

Abstract
This study aims to understand the students’ attitude towards e-learning under the forced environment of the COVID-19 pandemic. This study gives a fresh insight into e-learning, considering the lack of comprehensive research on the influencing variables that impact the user acceptance of e-learning by learners in the Indian Universities during COVID-19 pandemic. The rational model has been constituted based on the Technological Acceptance Model (TAM) and Self-Determination Theory (SDT) to study the effective influence of Autonomy, Relatedness & Competency on the construct of TAM. The result showed significant relations of the self-determination variables with perceived ease of use & perceived usefulness, which further helps us establish a relationship between intrinsic & extrinsic factors of SDT framework with attitude and satisfaction level of Indian University students towards e-learning. This study will assist in bridging the gap between the understanding of organizations and actual factors impacting students’ learning process during the pandemic of COVID-19.

Keywords
COVID-19 pandemic, E-learning, Extrinsic & intrinsic motivation, Self-determination theory (SDT), Technology Acceptance Model (TAM)

1 Introduction
In recent times, e-learning or Information & Communications Technology (ICT) has increasingly gained a crucial place in the education system across the globe. The suspension of physical classrooms across various universities has affected millions of students. The shift to e-learning mode came out as a propitious choice for the universities. The education sector has developed and reformed with the advent of recent digital technologies such as Live-stream; the universities were quick to shift to e-learning. According to Daniel et al., the higher education sector was approaching online learning for a long time to simplify education and make it more accessible. Universities have instituted strategies to blend in e-learning with the traditional pedagogical practices in order to continue the education program of their enrolled students without any setbacks, as stated by Roca & Gagné [1].

Universities around the globe are facing economic turbulence due to the worldwide lockdown. The adoption of pedagogical structure & the embodiment of e-learning systems are essential for the sustainability of universities, as observed by Racero et al. According to UNESCO, over 154-crore students worldwide are being affected by the closure of educational institutes. E-learning has a huge capability to help university students in continuing their formal education. However, the actual effectiveness of this system depends on many uncontrollable factors like the student’s attitude towards the system, student’s motivation - be it intrinsic or extrinsic [2]. Universities need to understand and analyze these factors for implementing and developing a better online learning system.

As the suspension of physical classes due to this pandemic was unanticipated, the quantum of research work with consideration of this new factor of compulsion to attend online classes is relatively less in number; thereby, a gap is created that needs to be addressed to accelerate further the educational programs of students at the similar pace. The classes are conducted on platforms like Zoom, Google Meet, MS-Teams, etc. The students have access to live & recorded lectures, class notes & information, and assessments, thus facilitating communication with co-learners & faculty [3].

In this research, the focus is on understanding the attitude, satisfaction, and motivation of students towards e-learning under forced conditions by analyzing the relationship between Self-Determination Theory (SDT) & Technology Acceptance Model (TAM) proposed framework. For several decades, researchers like Deci & Ryan have established a significant relationship between students’ & various positive learning outcomes [4].
When high motivation is observed in students, they tend to grasp topics in a more consistent manner and achieve higher academic performance. We try to understand the more consistently the need to feel ownership of one’s behavior”), competency (“the need to produce desired outcomes and to experience mastery”) & relatedness (“the need to feel connected to others”) on satisfaction in students pursuing formal education via e-learning. The perceptions and attitude of the instructor regarding e-learning plays a determining role in students’ e-learning usage; as researched by Albirini et al., Therefore, it is believed that teachers’ preparedness to employ e-learning can affect the program outcome [5]. We can identify multiple theoretical frameworks that were proposed to help in explaining and predicting the individuals’ attitudes & accept proposed to help explain and predict most important are the Theory of Reasoned Action (TRA), as in an evaluator study by Ajzen & Fishbein & it is various extensions, the Theory of Planned Behavior (TPB), as studied by Ajzen and TAM, as recorded by Davis. The TAM is being adapted from TRA, asserts that the significant determinants of an individual’s acceptance of the information system in education are Perceived usefulness (PU) & Perceived ease of use (PEOU). Similarly, Self-determination theory highlights psychological needs mandated for optimal best efficiency, well-being & growth of any individual in a new environment, according to Deci & Ryan [6].

2 Literature review

The ICT or e-learning literature has highlighted that researchers in this domain have been trying to understand the behavioral intention of use and attitude towards it. According to Areepattamannil & Khine, there is a variation of behavior observed among individuals & groups, respectively. Generally, the usage behavioral intention and attitude are studied through certain additional constructs that address the acceptance of emerging technologies in new environments, as stated by Malaquias et al. The fundamental and influential theoretical model predominantly used to explain e-learning acceptance is TAM [7].

The TAM, developed for studying the intention of any new technology, is developed on the principles mentioned in the “Theory of Reasoned Action,” as observed by Davis. Since then, it is used meticulously by many researchers in developing the predictive frameworks about the usage intention of any emerging technology, for example - mobile devices, Internet, open software or enterprise systems in disciplines like business, medical sector, educational sector, and economical sector, as researched by Malaquias et al. In the past studies, TAM had been employed to a vast array of purposes, such as measuring the perceptions of simulation-based learning amongst clinical students, or evaluating the acceptance of mobile technologies by teachers, etc [8].

Since our study is linked to students’ emotions and attitude regarding the acceptance of e-learning under forced situation (Compulsion of online education due to COVID-19 pandemic), SDT is incorporated to associate few external factors that complete and elevates the drafted framework. In recent years, the TAM blended with SDT has been extensively used in the literature. Strong compatibility in them has been found, as in an evaluator study by Nikou et al [9].

2.1 TAM

The TAM model can be considered a major factor behind the successful execution of the Information system (IS) and understanding its users’ acceptance. Being a widely accepted framework, TAM focuses primarily on the psychological interplay of an individual with new emerging technology. TAM helps us to understand how the user accepts information technology. The original TAM model comprises constructs namely PEOU, PU, Attitude (ATT), and Behavioral Intention to Use (BI) & Actual Use (AU) as shown in Figure 1 [10].
Research suggests that the two factors majorly influencing the ATT of the users toward using virtual-based learning are PU and PEOU, as studied by Davis [11]. Apart from these two factors, in several of this domain-related research, many other external constructs have been included to modify the TAM, affecting e-learning acceptance. These external constructs can be related to supporting technology, learner characteristics, subjective norms or aiding environment, etc. Previous research has emphasized the importance of analyzing and reviewing the impact of the motivational drivers on usage intention of e-learning systems, as recorded by Huang, but there lies a research gap that can be detected in the current pandemic situation COVID-19. Hence, further research is required for extensively understanding the influencing factors towards usage intention of e-learning for formal education under forced conditions [12].

2.2 SDT

SDT model, according to Deci & Ryan, is a contemporary macro-theory of motivation that signifies the methodical analysis of the dimensions of human motivational needs & welfare in the prevalent communal ecosystem [13]. The determinants of motivation in Self-Determination Theory are stated to be autonomy, relatedness, and competency.

2.3 SDT and TAM

Since the conceptualization of TAM, Davis underlined the significance of motivation and SDT towards individual’s acceptance of e-learning modules. SDT and TAM together have been proved as the pillars of user’s acceptance of new and emerging technologies across various disciplines, such as intention towards continual usage of e-learning in office, as stated by Roca & Gagné, acceptance of learning by using a mobile device, as observed by Nikou et al. In his research, Venkatesh showed that intrinsic motivation could be considered as computer playfulness that influenced the PEOU and system acceptance [14]. In his research, Lee et al. combined motivational perspective in the TAM, represented both intrinsic (perceived enjoyment) and extrinsic (PEOU & PU) motivations for understanding and explaining the students’ intention to embrace e-learning, as stated by Zhang et al.

In their research, Roca & Gagné had extended TAM to AUTO, REL, and COMP w.r.t continual e-learning in the workplace. It was found that all three SDT constructs have a direct or indirect influence on PEOU and PU [15]. Another study conducted by Sørebø et al. demonstrated that all the three SDT fundamental psychological needs with intrinsic motivation are found to help anticipate the teachers’ acceptance level regarding continuous usage of e-learning. Autonomous motivation influenced students’ decisions towards online education significantly, as observed by Zhou. Figure 2 shows our suggested framework [16].

3 Research frameworks

3.1 Autonomy

Autonomy is pertinent to self-regulation, which is in variation to forced regulation by external instruments. Autonomy reflects the distinctive acts that control an individual’s behavior. Although SDT is more focused on individual’s approval of the act, it also supports contingencies. Sense of ‘learning autonomy’ is observed in students in the education field, as researched by Nikou et al. In his research, Racero et al.
stated, "Autonomous motivation has a greater impact on satisfaction (SATIS), as compared to external motivations." Therefore, autonomy impacts the satisfaction of students in e-learning. Previously, various studies have proved the significant relationship between AUTO and PEOU similarly between AUTO and PU, as in an evaluator study by Roca & Gagné. Thus, we present the below-mentioned hypotheses [17]:

**H1**: AUTO has a significant relation with PEOU in e-learning

**H2**: AUTO has a significant relation with PU in e-learning

3.2 Relatedness

Relatedness in e-learning pertains to the scope of engagement in vivid activities that embraces teamwork, collaboration, and communication with co-learners, as studied by Sergis. Studies have shown that students have predominantly enjoyed social connections and social interactions according to the SDT model. Relatedness has also proved to be a strong determinant of students’ ATT to continue the educational program, as recorded by Roca & Gagné. The intrinsic nature of an e-learning environment where a student fosters new connections and collaboration guides in generalizing relevant behaviors. In e-learning, relatedness is considered one of the principal determinants of students’ behavior. It deals with the opinions of co-learners, and according to human psychology. People acknowledge they feel connected to the popular opinions of people. In his research, Racero et al. have proved significant relation between relatedness & PEOU and relatedness & PU. Thus, we present the below-mentioned hypotheses [18]:

**H3**: REL has a significant relation with PEOU in e-learning

**H4**: REL has a significant relation with PU in e-learning

3.3 Competency

According to Nikou et al., competency refers to expanding personal capabilities and the desire to be self-sufficient. SDT model indicated that competence acquiesces individuals to excel at tasks and achieve goals comfortably, according to Ryan & Deci. According to Leung & Matanda, certain factors, such as experience with technology, level of satisfaction, are associated with competency in the e-learning sector. Studies suggested that there lies a significant relation between Competency and Satisfaction in the case of learners, as stated by Aesaert et al [19]. On similar grounds, studies have also proved a significant relation between Competency and the PEOU & PU, as observed by Jeno et al. Hence, the below-mentioned hypotheses are formed:

**H5**: COMP has a significant relation with PEOU in e-learning

**H6**: COMP has a significant relation with PU in e-learning

3.4 Instructor characteristics

The instructor’s role has been considered due important from the researchers’ point of view. It is crucial for the success of virtual learning systems. Various studies conducted by many academicians have shown that Instructor Characteristics (INST) significantly affects learners’ satisfaction, as observed by Sun et al. Instructor quality was employed as a distinct element by Lwoga, wherein it confirmed that a significant relationship exists between the INST & PU and INST & SATIS. A model developed by Park and Roca & Gagné proved a significant relationship of Instructor Characteristics with PU and Satisfaction. Thus, we present the below-mentioned hypotheses:

**H7**: INST has a significant relation with PU in e-learning

**H8**: INST has a significant relation with SATIS in e-learning

3.5 PEOU and PU

PU is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance,” PEOU is “the degree to which a person believes that using a particular system would be free of efforts,” as researched by Davis. The previously conducted studies signified the impactful relation between usefulness and benefits, as in an evaluator study by Hwang et al. It was concluded by Al-Sabawy et al. that PU significantly and directly affects the satisfaction of users. Therefore, in this study, we assume that PEOU also impacts user satisfaction. Thus, we present the below-mentioned hypotheses:

**H9**: PEOU has a significant impact on SATIS in e-learning

**H10**: PU has a significant impact on SATIS in e-learning

3.6 Satisfaction

Satisfaction has been clearly and significantly reliable & validated w.r.t the e-learning domain (Al-Frai-
hat et al., 2020). In our framework, the underlying assumption is- user satisfaction is a catalyst of user attitude. The direct impact of learner’s satisfaction upon benefits and user Attitude was found significant by DeLone & McLean. It is stated, “When students using e-learning achieve satisfaction, they tend to use the system more, hence, developing an attitude towards it,” as studied by Hassanzadeh et al., 2012). Thus, we present the below-mentioned hypothesis:

**H11**: SATIS has a significant impact on students’ ATT in e-learning

### 3.7 Attitude

Attitude refers to “the degree to which a person has a positive or negative feeling towards e-learning systems.” It was stated by Salloum et al. the relationship of PEOU and PU with learner’s attitude towards usage intention of e-learning. Hence, in our framework, we are analyzing the influence of satisfaction on the attitude of users.

### 4 Research methodologies

This research has primarily used an online survey to accumulate the data from the desired respondents. The main reason for employing an online survey format is to target the appropriate sample and reach out to them considering the COVID-19 situation. The sample size comprises UG and PG students from various Indian universities currently undergoing online education after universities suspend physical classes. A total of 250 students were invited to fill the survey. Convenience sampling was adopted for the unbiased collection of data. 221 students responded in total, out of which 22 them were found unsuitable for analysis. Therefore, only 199 responses were used for further analysis. The online questionnaire used for this survey consisted of a five-point Likert Scale, where 1 represented 'Strongly Disagree' and 5 represented 'Strongly Agree.'

The scale instruments have been derived from the constructs in previously conducted studies. They are modified to align with this research. The survey instrument includes 6 items of Autonomy (AUTO), 5 items of Relatedness (REL) & 5 items of Competency (COMP) adapted from Racero et al., 4 items of Instructor Characteristics (INST) from Al-Fraihat et al. Ibrahim et al., 6 items of PEOU & 5 items of PU from Racero et al., 5 items of SATIS from Sunkara et al.; Al-Fraihat et al. and 5 items of Attitude (ATT) adapted from Salloum et al.

The data collected has been analyzed using SPSS version 25. The various analysis techniques employed for this research are ‘Linear Regression’ and ‘Multiple Regression test.’

#### 5 Data analysis and discussion

##### 5.1 Cronbach’s alpha

The reliability of the construct is tested to confirm and verify that the results obtained are consistent and reliable. The consistency of items scale used for each of the constructs are measured by reliability analysis in SPSS through Cronbach’s Alpha test. The admissible value is 0.7 was suggested by Nunnally. It is observed that Cronbach’s alpha is above 0.7 for the constructs, and the overall value is 0.908. Hence, we can consider the questionnaire to be a reliable measurement instrument in Table 2.

#### Table 2

| Scale                  | Cronbach’s Alpha | No. of Items |
|------------------------|------------------|--------------|
| Autonomy               | 0.808            | 4            |
| Relatedness            | 0.827            | 5            |
| Competency             | 0.796            | 5            |
| Instructor Characteristics | 0.783         | 4            |
| PEOU                   | 0.866            | 6            |
| PU                     | 0.802            | 5            |
| Satisfaction           | 0.814            | 5            |
| Attitude               | 0.818            | 5            |
| Overall value          | 0.908            | 39           |

Source: Author’s findings and calculations
Since multivariate problems often arise in these practical problems, many variables have significant relationships that might increase the complexity of analysis. So, Exploratory Factor Analysis (EFA) is carried out to address this problem. In carrying out EFA, the sampling adequacy is tested through KMO measures. The value obtained is computed as 0.930, which perfectly lies in the range defined by Kaiser, 1974. Bartlett’s Test of Sphericity, indicating a substantial relationship among the constructs.

5.2 Regression analysis

In consideration of the TAM and SDT framework, eleven hypotheses have been drafted. Regression statistics have been used to test the significance of each hypothesis. The summary of the regression data in Table 3 with certain observations like β value is high for high t-value and small p-value.

H1: Regression Analysis carried out to test the hypothesis with Autonomy (AUTO) as the predictor variable and PEOU as the dependent variable, we obtained (β=0.799, t=21.186, p<0.05). Hence, we can conclude that a significant relationship exists between AUTO and PEOU. The obtained outcome of R² is 0.695, indicating 69.5% of the variation in PEOU is explained by AUTO, which measures the overall stability of the association and reflects the extent to which a predictor factor is associated with a dependent factor. The unstandardized coefficient of β illustrates the degree to which the predictor variable predicts the dependent variable. For every one unit of change in AUTO, a 0.799 unit of change can be observed in PEOU. Hence, the hypothesis is accepted.

From Table 3, it can be observed that the obtained outcome of R² indicates the variation in the dependent variable explained by the predictor variable in each proposed hypothesis. The desired values of β, t & p confirm a significant relationship between a dependent variable and a predictor variable. The unstandardized coefficient of β illustrates the degree to which the predictor variable predicts the dependent variable. Therefore, we can say that H2, H3, H4, H5, H6, H7, H8, H9, H10, and H11 are supported.

As per the suggested framework in Figure 2, AUTO, REL, COMP & INST influence PU and AUTO, REL & COMP influence PEOU. The objective is to check whether this relationship significantly impacts PEOU and PU in e-learning. Similarly, PEOU, PU, and INST influence SATIS in e-learning. This research also emphasizes the impact of this relationship. Therefore, multiple regression analysis is carried out to check the significance of these relationships as shown in Table 4.

The obtained result proves the existence of a significant relationship between AUTO, REL, COMP (predictor variable), and PEOU (dependent variable) with the calculated value of (R²=0.725) indicating that the predictor variables explain 72.5% variation in the PEOU. The unstandardized coefficient of β illustrates the extent to which predictor variables predict the dependent variables. AUTO (β=0.636) has the strongest effect on PEOU, followed by REL (β=0.151). VIF (Variance Inflation Factor) and Tolerance are used to measure the presence of multicollinearity. VIF >10 and Tolerance < 0.2 indicates multicollinearity. From Table 5, we can see VIF values are between 2-4, and Tolerance values are in

| Hypothesis | Predictor Variable | Dependent Variable | Un-standardized Coefficients | F     | t     | p      | R²   | Hypothesis Supported? |
|------------|-------------------|-------------------|-------------------------------|-------|-------|-------|------|------------------------|
| H1         | AUTO              | PEOU              | 0.799 0.038                   | 448.852 | 21.186 | 0.00  | 0.695 | Yes                    |
| H2         | AUTO              | PU                | 0.621 0.05                    | 154.728 | 12.439 | 0.00  | 0.44  | Yes                    |
| H3         | REL               | PEOU              | 0.746 0.048                   | 239.752 | 15.484 | 0.00  | 0.549 | Yes                    |
| H4         | REL               | PU                | 0.787 0.042                   | 349.61  | 18.698 | 0.00  | 0.64  | Yes                    |
| H5         | COMP              | PEOU              | 0.705 0.056                   | 156.65  | 12.516 | 0.00  | 0.443 | Yes                    |
| H6         | COMP              | PU                | 0.855 0.042                   | 423.645 | 20.583 | 0.00  | 0.683 | Yes                    |
| H7         | INST              | PU                | 0.775 0.039                   | 391.136 | 19.777 | 0.00  | 0.665 | Yes                    |
| H8         | INST              | SATIS             | 0.805 0.04                    | 397.444 | 19.936 | 0.00  | 0.669 | Yes                    |
| H9         | PEOU              | SATIS             | 0.614 0.057                   | 114.633 | 10.707 | 0.00  | 0.368 | Yes                    |
| H10        | PU                | SATIS             | 0.916 0.034                   | 707.907 | 26.607 | 0.00  | 0.782 | Yes                    |
| H11        | SATIS             | ATT               | 0.843 0.039                   | 471.292 | 21.709 | 0.00  | 0.705 | Yes                    |

Source: Author’s findings and calculations
the acceptance range, signifying the absence of multicollinearity. Table 6 shown the result.

The obtained result proves the existence of a significant relationship between AUTO, REL, COMP, INST (predictor variable), and PU (dependent variable) with the calculated value of \( R^2 = 0.785 \) indicating that predictor variables explain 78.5% variation in the PU. INST (\( \beta = 0.373 \)) has the strongest effect on PU followed by COMP (\( \beta = 0.357 \)), REL (\( \beta = 0.199 \)), and AUTO (\( \beta = 0.142 \)). From Table 7, we can see VIF values are between 2-4, and Tolerance values are in the acceptance range, signifying the absence of multicollinearity. Table 8 shows the result.

The obtained result proves the existence of a significant relationship between PEOU, PU, INST (predictor variable), and SATIS (dependent variable) with the calculated value of \( R^2 = 0.810 \) indicating that predictor variables explain 81.0% variation in the SATIS. PU (\( \beta = 0.653 \)) has the strongest effect on SATIS, followed by INST (\( \beta = 0.290 \)) and PEOU (\( \beta = 0.117 \)). From Table 9,

### Table 4

| Model | R   | R²   | Adjusted R² | Std. The error of the Estimate |
|-------|-----|------|-------------|-----------------------------|
|       | .851| 0.725| 0.720       | 0.55404                     |

Source: Author’s findings and calculations

### Table 5

Multiple regression statistics

| Model | Unstandardized Coefficients | Standardized Coefficients | t   | Sig. | Collinearity Statistics |
|-------|------------------------------|---------------------------|-----|------|-------------------------|
|       | B               | Std. Error | Beta |     | Tolerance | VIF |
| (Constant) | 0.221 | 0.126 | 1.746 | 0.082 | | | |
| Autonomy     | 0.610 | 0.057 | 0.636 | 10.786 | 0.000 | 0.406 | 2.462 |
| Relatedness  | 0.152 | 0.077 | 0.151 | 1.969 | 0.049 | 0.341 | 4.146 |
| Competency   | 0.132 | 0.069 | 0.125 | 1.919 | 0.016 | 0.334 | 2.990 |

Source: Author’s findings and calculations

### Table 6

| Model | R   | R²   | Adjusted R² | Std. The error of the Estimate |
|-------|-----|------|-------------|-----------------------------|
|       | .886| 0.785| 0.781       | 0.47904                     |

Source: Author’s findings and calculations

### Table 7

Multiple regression statistics

| Model | Unstandardized Coefficients | Standardized Coefficients | t   | Sig. | Collinearity Statistics |
|-------|------------------------------|---------------------------|-----|------|-------------------------|
|       | B               | Std. Error | Beta |     | Tolerance | VIF |
| (Constant) | 0.070 | 0.112 | 0.628 | 0.531 | | | |
| Autonomy     | 0.040 | 0.049 | 0.142 | 0.805 | 0.022 | 0.402 | 2.487 |
| Relatedness  | 0.195 | 0.069 | 0.199 | 2.836 | 0.005 | 0.225 | 4.437 |
| Competency   | 0.369 | 0.064 | 0.357 | 5.772 | 0.000 | 0.290 | 3.450 |
| Instructor Characteristics | 0.354 | 0.051 | 0.373 | 6.888 | 0.000 | 0.378 | 2.649 |

Source: Author’s findings and calculations
we can see VIF values are close to 3, and Tolerance values are in the acceptance range, signifying the absence of multicollinearity.

Thus, the proposed framework holds for this domain as proven through the data analysis.

6 Conclusions

The spread of COVID-19 has forced most of the service industry around the world to look for alternatives to sustain. The Internet became the savior, and ‘Online became the ‘New Normal.’ The education industry is also forced to shift from offline to online overnight, impacting millions of students and teachers worldwide. Students in the middle of their academic year are forced to accept and adapt to the new technology of e-learning. Under TAM's conceptual framework with SDT, the proposed hypotheses were tested to comprehend better the influencing determinants of e-learning acceptance by students pursuing their educational degree.

The statistical outcome of the applied data analysis techniques empirically supports the proposed hypothesis. The obtained results suggest that a student’s psychological need fulfillment helps accept new technology under various situations and circumstances. All the SDT constructs and an external construct of 'Instructor characteristic' have a significant relation with PU and further with satisfaction. These relationships gave insights to comprehend the relationship between satisfaction & attitude of learner w.r.t online education. This study’s findings strongly indicate that even in a forced environment, intrinsic motivational factors play a dominant and pivotal role in molding the attitude of students towards acceptance of e-learning. Organizations need to improve the factors, such as AUTO, REL & COMP, to facilitate the online education's acceptance through enhanced experience.

With adequate infrastructure required for the smooth functioning of e-learning, further studies can be carried out to understand the technical system quality or support system quality. A comparative study can also be conducted on the cost of traditional education methods and online modes of education. Since we have only studied a sample of university students, the drivers for e-learning acceptance can differ for students with changing pedagogy. Generalization of this framework would be unsatisfactory, thus leaving a further scope of research.

Statement on ethical issues

Research involving people and/or animals is in full compliance with current national and international ethical standards.

Conflict of interest

None declared.

Author contributions

The authors read the ICMJE criteria for authorship and approved the final manuscript.
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