Dynamic Friendship Network and Breakfast-Eating Behavior

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Abstract: A longitudinal data was collected at six time points, Oct. and Dec. in 2005, Jan., Feb., Apr., and June in 2006. The questionnaires contain questions on health behaviors, and friendship data. The Markov model is based on transition tables that describe the transition from network position and breakfast-eating behavior at time points 1 to 2, 2 to 3, 3 to 4, 4 to 5, and 5 to 6. The states are classified into isolate breakfast-eater (ISb), group member breakfast-eater (GPb), isolate breakfast-skipper (ISNb), and group member breakfast-skipper (GPNb). The results indicate that most of the students keep their breakfast eating behavior, the transition probabilities are constant at the later stages, and group members have longer sojourn time. We conclude that friendship network is an evolution process, and will eventually reach an equilibrium status. The influences of friendship network can not ignored and the difference between “micro” and “macro” level of social network transition under Markov model needs further scrutinized.

Key words: Friendship network, Health behavior, University students, Markov Chain

1 Introduction
Eating breakfast is a very important health behavior but easily to be ignored. Health behavior denotes those actions undertaken by persons who believe they are well, and who are not experiencing any signs or symptoms of illness, for the purpose of remaining well [1]. Breslow and his colleagues [2] have provided systemic evidence of the impact of six categories of everyday nonmedical behaviors upon health status and health risk. These behaviors are duration of sleep; eating habits, including eating breakfast; weight management; physical recreational activity; consumption of alcoholic beverages; and not smoking. People who practice these behaviors are more healthy and longevity.

Health behaviors are learned during the
process of growth and development through parental and peer modeling. Social relationships have been found to influence a variety of health behaviors. Durkeim’s [3] approach to the study of social integration and its consequences paved the way for modern research on group structures and health behavior. He believed that frequent social contacts promoted social integration by reducing tendencies toward self-centeredness and egoism.

Most people have social ties with relatives and friends and memberships in various types of organization. Berkman and Syme [4] observed some social networks to be associated with poor health practices: smoking, drinking, bad eating habits, obesity. Berkman suggested that peer pressure may be an important factor determining whether one engages in health-promoting behaviors [5]. However, very little is known about which network characteristics affect health belief [6]. In order to understand the mechanisms that link social network and health behaviors, studies should consider changes in health behavior over time and include network characteristics.

Breakfast eating behavior seems trivial but important. Rampersaud et al. [7] reviewed 47 studies and indicated that children and adolescents who usually have breakfasts generally consumed more daily calories than those who skip this meal and, yet, are less likely to be overweight. The same authors offered evidence to suggest that breakfast consumption may improve cognitive function related to memory, test grades, and school attendance. However, the frequency of breakfast eating declined with age [8]. Rampersaud’s review [7] found that children and adolescents skipped breakfast more than any other meal, and the approximate percent of children and adolescents who skipped breakfast was 8% for aged 1 to 7, 12% for aged 8 to 10, 20% for aged 11 to 14, and 30% for aged 15 to 18. Obviously, breakfast-eating behavior is an important issue to be studied.

Adolescent eating patterns are established through a complex process. Most of the studies focus on family’s influences. Videon and Manning [9] indicated that parental presence at meal time was associated with the likelihood of skipping breakfast. As adolescent entered university, the frequency of eating with their families decreases. They spend more time away from home, especially when they live in dormitory. The interaction with peers will be an important factor influencing their eating behavior. Within peer groups, a person who observes another accepting or supporting an object is likely to do the same. The decreased frequency of eating breakfast might result from peer influence.

Markov models provide a convenient framework for analyzing the structural mechanisms which underlie social change and for extrapolating shifts in the state distribution of a population [10]. The present research examined the dynamic friendship networks and the breakfast eating habit under the assumption of a continuous-time Markov process. The aim is to test whether friendship network will influence breakfast eating behavior.

2 Methods

A longitudinal data was collected at six time points, Oct. and Dec. in 2005, Jan., Feb., Apr., and June in 2006. There are 58, 87, 77, 80, 71, and 72 university freshmen participated in the six different time points. The analysis included the subjects who completed two adjacent questionnaires. The questionnaires contain questions on health behaviors, and friendship data. The subjects were asked to nominate up to ten best friends. In this research,
only the first three best friends and breakfast eating behavior are analyzed.

The network positions of the subjects are classified as isolates and group members. The isolate is the one who has no friend. He does not nominate any friend, or he is not nominated by any one. The group members have at least one symmetric good friend.

The Markov model is based on transition tables that describe the transition from network position and breakfast-eating behavior at time points 1 to 2, 2 to 3, 3 to 4, 4 to 5, and 5 to 6. The states are classified into isolate breakfast-eater (ISb), group member breakfast-eater (GPb), isolate breakfast-skipper (ISNb), and group member breakfast-skipper (GPNb).

### 3 Results

The transition tables and probability matrixes are shown as table 1 to 5.

<table>
<thead>
<tr>
<th>Oct. to Dec.</th>
<th>ISb</th>
<th>GPb</th>
<th>ISNb</th>
<th>GPNb</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISb</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>GPb</td>
<td>3</td>
<td>34</td>
<td>2</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>ISNb</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>GPNb</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>42</td>
<td>5</td>
<td>4</td>
<td>58</td>
</tr>
</tbody>
</table>

Table 1 Transition Table and Probability Matrix (Oct. to Dec.)

<table>
<thead>
<tr>
<th>Dec. to Jan.</th>
<th>S3</th>
<th>ISb</th>
<th>GPb</th>
<th>ISNb</th>
<th>GPNb</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISb</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>GPb</td>
<td>10</td>
<td>37</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>48</td>
</tr>
<tr>
<td>ISNb</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>GPNb</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>41</td>
<td>7</td>
<td>11</td>
<td>0</td>
<td>76</td>
</tr>
</tbody>
</table>

Table 2 Transition Table and Probability Matrix (Dec. to Jan.)

<table>
<thead>
<tr>
<th>Jan. to Feb.</th>
<th>S4</th>
<th>ISb</th>
<th>GPb</th>
<th>ISNb</th>
<th>GPNb</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISb</td>
<td>2</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>.14</td>
<td>14</td>
</tr>
<tr>
<td>GPb</td>
<td>1</td>
<td>38</td>
<td>1</td>
<td>1</td>
<td>.02</td>
<td>41</td>
</tr>
<tr>
<td>ISNb</td>
<td>2</td>
<td>1</td>
<td>.40</td>
<td>.40</td>
<td>.20</td>
<td>.0</td>
</tr>
<tr>
<td>GPNb</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>.50</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>54</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>68</td>
</tr>
</tbody>
</table>

Table 3 Transition Table and Probability Matrix (Jan. to Feb.)

We denote the Probability transition matrix by $P_{ij}$. $P_{ij}$ denotes the probability that the process goes from state $i$ to state $j$. If the probability of the process initially being in state $j$ is $p_j$, then the probability of the process being in state $k$ is $p_k = \sum P_{jk}p_j$.

The Markov chain assumptions are stationarity, Markovian, and homogeneity of population [11]. The stationarity means that the transition probabilities remain constant over time. Markovian means the probability of transition to a given state during the next time unit depends only on the current state of the process and not on its history of previous moves from state to state. The various members of the population are subject to identical sets of transition probabilities.

Under stationary Markovian assumptions, the status at time k+1 can be predicted as:

\[ p_{k+1} = \sum p_j P_{jk}. \]

\[ p_3 = \Sigma p_1 P_{12} = [6.17, 41.70, 5.42, 4.72] \]
\[ p_4 = \Sigma p_2 P_{23} = [19.36, 37.46, 6.80, 12.38] \]
\[ p_5 = \Sigma p_3 P_{34} = [3.23, 57.43, 2.67, 4.67] \]
\[ p_6 = \Sigma p_4 P_{45} = [6.92, 52.15, 1.98, 5.94] \]

We then apply a chi-square test to compare the observed with the expected results, as table 6. The chi-square values do not attain significance at the 0.05 level for S5 and S6, indicating that the transition probabilities are constant at the later stages. The significant difference occurred at status 3 and 4. It indicates that the observed results at the beginning stage are different from those expected.

Between Dec. 2005 and Jan. 2006, the isolate breakfast-eater increased, and group member breakfast-eater decreased. Between Jan. and Feb. 2006, the isolate breakfast-eater decreased, and group member breakfast-eater increased.

Most of the students keep their eating habits. Only small portion of the subjects change their eating habits. From Oct. to Dec., 5 students become breakfast skippers, 3 become breakfast eaters. From Dec. to Jan., 2 students become skippers, 1 become eaters. From Jan. to Feb., 3 students become skippers, 7 become eaters. From Feb. to Apr., 5 students become skippers, 4 become eaters. From
Apr. to Jun. 5 students become skippers, 2 become eaters.

The length of time students spent in each transitional state was modeled using the maximum likelihood approach [12]. The transition process can be specified in terms of the transition intensities,

\[ q_{ij}(t) = \lim_{\Delta t \to 0} \frac{p_{ij}(t, t+\Delta t)}{\Delta t}, \quad i \neq j. \]

Let \( Q(t) \) be the transition intensity matrix with entries \( q_{ij}(t) \), and \( Q = (q_{ij}) \) denote the transition intensity matrix. \( q_{ij} = 0 \) for \( i \neq j \) and \( \sum q_{ij} = 0 \). And

\[ P(t) = e^{Qt} \]

The results, as table 7, show that group breakfast-eater spend, on average, the longest time, and followed by group breakfast-skipper. The times spend during S2-S3 for each status is longer than others except group breakfast-eating.

Table 7 Expected Sojourn Times

<table>
<thead>
<tr>
<th></th>
<th>ISb</th>
<th>GPb</th>
<th>ISNb</th>
<th>GPNb</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1-S2</td>
<td>0.90</td>
<td>4.09</td>
<td>0.86</td>
<td>0.74</td>
</tr>
<tr>
<td>S2-S3</td>
<td>2.03</td>
<td>3.27</td>
<td>3.50</td>
<td>8.38</td>
</tr>
<tr>
<td>S3-S4</td>
<td>0.66</td>
<td>9.69</td>
<td>0.75</td>
<td>1.49</td>
</tr>
<tr>
<td>S4-S5</td>
<td>0.87</td>
<td>4.37</td>
<td>0.49</td>
<td>1.47</td>
</tr>
<tr>
<td>S5-S6</td>
<td>1.76</td>
<td>4.07</td>
<td>0.50</td>
<td>3.31</td>
</tr>
<tr>
<td>Average</td>
<td>1.24</td>
<td>5.10</td>
<td>1.22</td>
<td>3.08</td>
</tr>
</tbody>
</table>

4 Conclusion

Breakfast eating behavior is an important health behavior. A longitudinal data at different time points in the history of a friendship network will help to observe the dynamic network structure and the change of eating behavior. Markov model is a mathematical formulation that permits researchers to focus upon the dynamic properties of a social process [9]. The results showed that the transition process is stationary at later stages. The evolution of the friendship structure is emerging over time. The results indicate that a friendship network eventually reaches an equilibrium state. In another word, at equilibrium state, the transitions between states continue to occur, but the probability that a subject is in a specific state approaches a constant.

Many studies showed the network process was stationary in time. These studies concentrate on the local or “micro” structure of a social group by examining subgraphs, particularly dyads and triads [13,14]. The friendship network evolution is a process of initiation, formation, maintenance, or severance. This process encompasses the changes of the entire network. The entire network is the “macro” level, not a single tie or the collection of ties. The difference between “micro” and “macro” level of social network transition under Markov model needs further scrutinized.

The rate of breakfast-skipping is between 0.10 and 0.22. The result showed that few students change their breakfast eating habit and cannot tell us whether friendship network would influence the eating habit. However, the results show that the group members, both breakfast-eater and breakfast-skipper, have longer sojourn time. It suggests that social connections attract each other. We can not ignore the influence of friendship network.

Reference:


