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PREDICTION OF GROWTH HORMONE RELEASE IN HUMANS BY STRONG GHRELIN DOSAGE USING MARKOV CHAIN ANALYSIS

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Abstract:

In this paper the study aims at trying to predict the increase in human growth hormone by injecting strong Ghrelin dosage applying Markov Chain Analysis (MCA). Ghrelin is a recently identified endogenous legend for the Growth hormone (GH) secretagogue receptor and is involved in a novel system for regulating GH release. However, we studied growth hormone secretagogue in humans. Taking four male adults Ghrelin was injected and it produced and released GH in a dose dependent manner and 0.2, 1.0 and 5.0 µg/kg subsequently produced peak level of GH at 30 minutes. We have described the application of MCA models for purpose of GH prediction in Human. Discrete state spaces are defined for MCA models and appropriate Transition probability matrix are calculated. These objects represent the results of the human growth predicting by using MCA and is reported by various doses of Ghrelin. The TPM gives growth level showing increases by 0 to 1 and also decreases by 1 to 0 levels.

Key Words: Markov Chain Analysis, Transition Probability Matrix, Ghrelin & Growth Hormone

1. Introduction:

Growth hormone is released from the anterior pituitary under the regulation of two hypothalamic peptides, GHRH and somatostain, while small synthetic molecules called GH secretagogues (GHS_s) such as GH–releasing peptide-2 [2,4] stimulate GH release from the pituitary through a specific receptor separate from those for GHRH or somatostain. The growth hormone secretagogue receptor (GHSR) also known as the Ghrelin receptor, acts close to pituitary and hypothalamus. It is heterotrimeric G protein – coupled receptor (GPCR) containing 366 amino acids with the typical screen transmembrane domains. Both the peptide (GHRP-6) and non peptide (MR-0677) Ghrelin secretagogues stimulate growth hormone release through activation of this specific GCPR expressed on the surface of somatotroph in the anterior pituitary gland. Its endogenous legend was identified a few years later from stomach extract named Ghrelin.

In this model, the parameters have set in order to fit plasma Ghrelin concentration data taken from the literature, related to an experiment in humans. Simulated-based Ghrelin predictions provided promising results if compared to real data besides to offer a proper description of the short term Ghrelin dynamics, the model could be thought of as a model of a bigger multi-compartmental structure.

Ghrelin is identified as being involved in both short-term control and long-term control. In this paper it is devoted to introduce the transition probability matrix of the Ghrelin with short term of the quantitative behaviour of the model solution. Section 2 explains the parameters that have been set to fit Ghrelin concentration samples taken from four different humans.

2. Markov Chain Models:

First our study aims at trying to predict the human's growth by injecting strong Ghrelin in human GH when MCA Model is applied. A Markov chain (MC) is special kind of stochastic process where the next state of the system depends only on the current and not on the previous ones. Stochastic processes inform of discrete sequence of random variables $\{X_n\}, n = 1,2,3, \ldots$ is said to have the Markov property. In [1] any finite$n$, where particular realizations X_n belongs to discrete state space $S = \{S_i\}, i = 1,2 \ldots\ldots k$.

Generally MC is described by vectors $P(n)$ which gives unconditional probability distribution of states and transition probability matrix P which gives conditional probabilities

$$P_{ij} = P\left\{X_{n+1} = \frac{s_j}{X_n} = s_i\right\}, i, j = 1,2, \ldots k$$

Where P_{ij} may depend on n. In such case we say about non-homogenous MC on the contrary homogenous MC where P_{ij} does not depend on n

$$P(X_{n+1} = x_{n+1}/ X_1 = x_{1,}, X_2 = x_{2,}, \ldots X_n = x_n) = P(X_{n+1} = x_{n+1}/ X_n = x_n) \qquad \text{------ (1)}$$

$$P(n+1)^T = P(n)^T P, \quad n = 1,2 \ldots \qquad \text{------ (2)}$$

The application of Markov Chain is used to analyse human growth [3] [7]. We concern modelling of the Ghrelin stimulate growth hormone releasing in humans and its growth levels depending upon the various doses of Ghrelin in 180 minutes of a day. We have utilized the set of growth values Pt in a day, and calculate the time series R_t in a chain index of a day then the growth values given by

$$R_t = {G_t}/{G_{t-1}}$$

3. Methodology:

The present study analyses the serum GH levels after injecting various (0.2, 1.0 and 5.0µg/kg) doses of Ghrelin, then Growth Hormone released in human being, the growth levels depends upon the injected individual. All doses produced mono- phasic responses and reached peak value at 30 minutes in human growth, while all level of doses resulted to give same time peak values of hormones. There was no significant changes and returned basal level at 180 minutes.

Level 1:

Table shows that serum GH levels after 0.2µg/kg injection of Ghrelin, then the growth values are given

G_t	0.1	0.3	0.5	1.4	1.8	2.4	2.8	3.2
	3.8	4.2	4.8	4.3	3.7	3.1	2.9	2.7
	2.3	1.8	1.6	1.2	0.7	0.5	0.3	0.1
R_t		0.2	0.2	0.9	0.3	0.6	0.4	0.4
	0.6	0.4	0.6	0.5	0.6	0.6	0.2	0.3
	0.4	0.5	0.2	0.4	0.5	0.2	0.2	0.2

Table 1: Calculation of R_t

Case 1: There is lay with just two states distinguishing either growth or decrease of R_t. If $R_t < 0.5$ the state is denoted by G where as for $R_t \geq 0.5$ the corresponding state is denoted by D. To calculate R_t yields the matrix P is given by (3)

$$\text{P} = \begin{bmatrix} 0.5 & 0.5 \\ 0.6 & 0.4 \end{bmatrix} \quad \text{------ (3)}$$

This equation (3) is not yielding. Both columns are just slightly difference, so the growth level is not seen well.

Case 2:

It has eight states $[G_4, G_3, G_{2,} G_1, D_1, D_2, D_3, D_4]$ different levels of growth and decrease of R_t is given by releation (4)

$$G_4: R_t \leq 0.2,\ \ G_3: 0.2 < R_t \leq 0.3, G_{2,}: 0.3 < R_t \leq 0.4, G_1: 0.4 < R_t \leq 0.5, D_1: 0.5 < R_t \leq 0.6$$
$$D_2: 0.6 < R_t \leq 0.7,\ D_3: 0.7 < R_t \leq 0.8, D_4: 0.8 < R_t \leq 0.9 \quad \text{------- (4)}$$

Applying the same procedure, we get the transition probability matrix P and conditional probabilities of Growth $Gq_i = \sum_{j=1}^{4} P_{ij}$ and decrease $Gq_i = \sum_{j=5}^{8} P_{ij}$ depending upon the states G_i and $D_{i,}$ $i = 1,2,3,4$ respectively. Both matrices are implemented in equation (5). Searching for Maximum value in column matrix$Q$, we can conclude that the state G_3 provides 0.5 to increasing the state D_4 provides 1.0 probability of growth, and the state G_3 provides 0.5 to decreasing the state D_4 provides 0.0

$$P = \begin{bmatrix} 0.2 & 0.2 & 0.0 & 0.1 & 0.0 & 0.2 & 0.2 & 0.1 \\ 0.1 & 0.2 & 0.0 & 0.2 & 0.1 & 0.1 & 0.2 & 0.1 \\ 0.0 & 0.2 & 0.2 & 0.2 & 0.1 & 0.1 & 0.1 & 0.1 \\ 0.1 & 0.1 & 0.1 & 0.3 & 0.0 & 0.2 & 0.1 & 0.1 \\ 0.0 & 0.2 & 0.2 & 0.3 & 0.2 & 0.0 & 0.0 & 0.1 \\ 0.3 & 0.2 & 0.2 & 0.1 & 0.0 & 0.0 & 0.1 & 0.1 \\ 0.1 & 0.4 & 0.3 & 0.1 & 0.0 & 0.0 & 0.1 & 0.1 \\ 0.0 & 0.3 & 0.5 & 0.2 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \text{Q} = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.5 \\ 0.6 & 0.4 \\ 0.6 & 0.4 \\ 0.7 & 0.3 \\ 0.8 & 0.2 \\ 0.9 & 0.1 \\ 1 & 0 \end{bmatrix} \quad \text{------ (5)}$$

Level 2:

Table shows that after 1.0µg/kg injection of Ghrelin, then the growth values are given.

G_t	0.2	0.8	1.5	2.5	3.0	3.6	4.5	5.2
	5.8	6.5	7.4	6.9	6.6	5.7	5.2	4.4
	3.5	2.8	2.2	1.8	1.3	0.5	0.3	0.1
R_t		0.6	0.7	1.0	0.5	0.6	0.9	0.7
	0.6	0.7	0.9	0.5	0.3	0.9	0.5	0.8
	1.1	0.7	0.6	0.4	0.5	0.8	0.2	0.2

Table 2: Calculation of R_t

Case 1:

There is second dosage level with just two states distinguishing either growth or decrease of R_t. If $R_t < 0.5$ the state is denoted by G where as for $R_t \geq 0.5$ the corresponding state is denoted by D. To calculate R_t yields the matrix P is given by (7)

$$\text{P} = \begin{bmatrix} 0.4 & 0.6 \\ 0.6 & 0.4 \end{bmatrix} \quad \text{------- (7)}$$

This equation (7) is not yielding, since both columns are just slightly difference, so the growth level as not seen well.

Case 2:

It has eight states $[G_4, G_3, G_{2,}G_1, D_1, D_2, D_3, D_4]$ different levels of growth and decrease of R_t is given by relation (8)

$$G_4: R_t \leq 1.5, G_3: 1.5 < R_t \leq 3.0, G_{2,}: 3.0 < R_t \leq 4.5, G_1: 4.5 < R_t \leq 6.0, D_1: 6.0 < R_t \leq 7.5$$
$$D_2: 7.5 < R_t \leq 9.0,\ D_3: 9.0 < R_t \leq 1.05,\ D_4: 1.05 < R_t \leq 1.20 \qquad \text{------- (8)}$$

Applying the same procedure, we get the transition probability matrix P and conditional probabilities of Growth $Gq_i = \sum_{j=1}^{4} P_{ij}$ and Decrease $Gq_i = \sum_{j=5}^{8} P_{ij}$ depending upon the states G_i and $D_{i,}\ i = 1,2,3,4$ respectively. Both matrices are implemented in equation (9). Searching for Maximum value in column matrix Q, we can conclude that the state G_3 provides 0.3 to increasing the state D_4 provides 1.0 probability of growth, and the state G_3 provides 0.7 to decreasing the state D_4 provides 0.0

$$P = \begin{bmatrix} 0.1 & 0.1 & 0.0 & 0.1 & 0.2 & 0.1 & 0.3 & 0.1 \\ 0.1 & 0.1 & 0.0 & 0.2 & 0.2 & 0.1 & 0.2 & 0.1 \\ 0.1 & 0.2 & 0.3 & 0.0 & 0.1 & 0.2 & 0.1 & 0.0 \\ 0.2 & 0.1 & 0.2 & 0.1 & 0.0 & 0.1 & 0.1 & 0.2 \\ 0.1 & 0.3 & 0.2 & 0.1 & 0.1 & 0.0 & 0.1 & 0.1 \\ 0.2 & 0.1 & 0.3 & 0.2 & 0.0 & 0.0 & 0.1 & 0.1 \\ 0.1 & 0.4 & 0.2 & 0.2 & 0.0 & 0.0 & 0.1 & 0.0 \\ 0.2 & 0.1 & 0.4 & 0.3 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad Q = \begin{bmatrix} 0.3 & 0.7 \\ 0.4 & 0.6 \\ 0.5 & 0.5 \\ 0.6 & 0.4 \\ 0.7 & 0.3 \\ 0.8 & 0.2 \\ 0.9 & 0.1 \\ 1 & 0 \end{bmatrix} \qquad \text{------ (9)}$$

Level 3:

Table show that after 5.0µg/kg injection of Ghrelin, then the growth values are given.

G_t	0.5	1.2	1.8	2.5	3.2	4.3	4.6	5.2
	6.1	6.9	7.2	7.7	8.2	8.6	9.5	9.1
	8.1	7.0	6.5	5.3	4.2	3.9	3.1	2.6
	2.3	1.7	1.1	0.8	0.5	0.2		
R_t		0.7	0.6	0.7	0.7	1.1	0.3	0.6
	0.9	0.8	0.3	0.5	0.5	0.4	0.9	0.4
	1.0	1.1	0.5	1.2	1.1	0.3	0.8	0.5
	0.3	0.6	0.6	0.3	0.3	0.3		

Table 3: Calculation of R_t

Case 1:

In the third dosage level with just two states distinguishing either growth or decrease of R_t. If $R_t < 0.5$ the state is denoted by G where as for $R_t \geq 0.5$ the corresponding state is denoted by D. To calculate R_t yields the matrix P is given by (10)

$$P = \begin{bmatrix} 0.4 & 0.6 \\ 0.7 & 0.3 \end{bmatrix} \qquad \text{------- (10)}$$

This equation (10) is not yielding, since both columns are just slightly difference, so the growth level as not noticed well.

Case 2:

It has eight states $[G_4, G_3, G_{2,}G_1, D_1, D_2, D_3, D_4]$ different levels of growth and decrease of R_t is given by relation (11)

$$G_4: R_t \leq 1.5, G_3: 1.5 < R_t \leq 3.0, G_{2,}: 3.0 < R_t \leq 4.5, G_1: 4.5 < R_t \leq 6.0, D_1: 6.0 < R_t \leq 7.5$$
$$D_2: 7.5 < R_t \leq 9.0,\ D_3: 9.0 < R_t \leq 1.05,\ D_4: 1.05 < R_t \leq 1.20 \qquad \text{------- (11)}$$

Applying the same procedure, we get the transition probability matrix P and conditional probabilities of Growth $Gq_i = \sum_{j=1}^{4} P_{ij}$ and decrease $Gq_i = \sum_{j=5}^{8} P_{ij}$ depending upon the states G_i and $D_{i,}\ i = 1,2,3,4$ respectively. Both matrices are implemented in equation (`11).

Searching for Maximum value in column matrix Q, we can conclude that the state G_4 provides 0.0 to increasing the state D_4 provides 1.0 probability of growth, and the state G_4 provides 1.0 to decreasing the state D_4 provides 0.0

$$P = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.2 & 0.1 & 0.5 & 0.2 \\ 0.0 & 0.0 & 0.1 & 0.1 & 0.1 & 0.2 & 0.4 & 0.1 \\ 0.0 & 0.1 & 0.1 & 0.1 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.0 & 0.0 & 0.2 & 0.3 & 0.1 & 0.0 & 0.3 & 0.1 \\ 0.1 & 0.3 & 0.1 & 0.1 & 0.0 & 0.2 & 0.1 & 0.1 \\ 0.0 & 0.3 & 0.2 & 0.3 & 0.0 & 0.0 & 0.1 & 0.1 \\ 0.1 & 0.3 & 0.2 & 0.3 & 00 & 0.0 & 0.1 & 0.0 \\ 0.1 & 0.3 & 0.4 & 0.2 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad Q = \begin{bmatrix} 0 & 1 \\ 0.2 & 0.8 \\ 0.3 & 0.7 \\ 0.5 & 0.5 \\ 0.6 & 0.4 \\ 0.8 & 0.2 \\ 0.9 & 0.1 \\ 1 & 0 \end{bmatrix}$$

4. Conclusion:

The three doses of Ghrelin (0.5, 1.0 & 5.0µg/kg) strongly stimulates the growth hormone released in humans. The growth reaches the peak values at 30 minutes further when we inject more than 5.0µg/kg doses of Ghrelin, the growth is increased and it will be stable at certain stage. After administration of these doses, growth level had returned to basal level at180 minutes. In the same manner, the data is used for MCA model. In this model the Transition Probability Matrix gives the growth level also increases by 0 to 1 and decreases by 1 to 0 level.

5. References:

1. Brock, W., Lakonishok, J. and LeBaron,B. (1992): Simple Technical Trading Rules and The Stochastic Properties of Stock Returns Journal of Finance 47 , Pp 1731 – 1764.
2. Casanueva F F, Dieguez C. (1999) Growth hormone secretagogues: physiological role and clinical utility Trends. Endocrinol Metab 10: Pp 30 -38.
3. Doubleday, K., J and Esunge, J.,N.(2011): Application of Markov Chains to Stock Trends. Journal of Mathematics and Statistics 7(2), Pp 103 – 106.4
4. Howard A D, Feighner S D, Cutly D F,et al. (1996) A receptor in Pituitary and hypothalamus that functions in growth hormone release, Science 273: Pp 974 – 977.
5. Kazultiko Takaya et.al (2000) Ghrelin strongly stimulates Growth hormone (GH) Release in humans. The journal of clinical endocrinology metabolism, Vol 85, No: 12.
6. Milan Svoboda, Ladislav Lukas (2012) Application of Markov chain analysis to trend prediction of stock indices, proceedings of 30th International conference Mathematical methods in Economics, Pp 843-853.
7. Pandya N, DeMott –Friberg R, Bowers C Y, Barkan A L, Jaffe C A. (1998) Growth
8. Hormone (GH) releasing peptide -6 requires endogenous hypothalamic GH- releasing hormone for maximal GH stimulation. J. Clin Endocrinol Metab 83: Pp 1186 – 1189.