

**A COMPUTATIONAL MODEL TO SIMULATE TEMPORAL
DYNAMICS IN CHRONIC FATIGUE SYNDROME**

UNIVERSITI UTARA MALAYSIA

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ABSTRACT

People who are exposed to chronic fatigue have the risk of developing physiological and psychological problems. Hence, it is essential to comprehend the development of chronic fatigue in order to support the persons with such risk. The main objective of the study was to develop a computational model for temporal dynamic change during chronic fatigue. The methodology that was used to explore human cognitive processes in chronic fatigue consisted of four phases: identification of local and non-local dynamic properties, formalization of local and non-local dynamic properties, simulation, and evaluation. This kind of model brings benefits to psychologists in terms of acquiring more insight pertaining to chronic fatigue by simulating multiple conditions on digital environments. The factors that were identified to have direct/indirect influence on chronic fatigue syndrome were negative personality factors, periodic over-activity, low job control, psychological stressors, physiological stressors, viral infection, mental load, emotional demand, work demand, short term stress, long term stress, viral susceptibility, immune system production, immune response, short term resistance level, long term resistance level, short term exhaustion, long term exhaustion, short term fatigue, long term fatigue, and chronic fatigue syndrome. The factors were used to construct the computational model. The model was simulated by applying it to five different scenarios, healthy person (scenario #1), moderate person (scenario #2), high risk individual (scenario #3), person with lack of planning (scenario #4), and embattled personality (scenario #5). The computational model was verified using mathematical analysis. Results showed that the computational model was able to show the effect of CFS to different types of scenarios.

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List of Abbreviations

CFS	Chronic Fatigue Syndrome
ME	Myalgic Encephalomyelitis
CDC	Centre for Disease Control
CBT	Cognitive Behavioural Therapy
GET	Graded Exercise Therapy
F&S	Fatigue and Somatic
REBT	Rational Emotive Behavioural Therapy
IO&NS	Inflammatory, Oxidative and Nitrosative Stress

CHAPTER ONE

INTRODUCTION

This chapter briefly explains the study background, problem statement, objectives, significance and scope of the study.

1.1 Background of the Study

In recent years, an increasing amount of research has focused on the issue of chronic fatigue and chronic fatigue syndrome (CFS) (Kato et al., 2006). In organizational, chronic fatigue has been implicated in poor performance (Rose et al., 1994) and people's behaviours (Arnold et al., 1991). CFS is one of many descriptions of an illness known in the United Kingdom as "Myalgic Encephalomyelitis (ME)", or in the United States as "chronic fatigue and immune deficiency syndrome" (Wessely, 1997). CFS probably appeared during the middle of the 19th century, although some argue that similar illnesses were described as early as the 17th century. (Evengaerd et al., 1999).

Chronic fatigue is a widespread phenomenon which recognized as a serious symptom of different chronic illness that can significantly impair a person's functioning and decreases the life quality as well as workplace productivity (Bombardier et al., 1996). It is characterized by a wide range of cognitive, physiological, neurological, and emotional symptoms that last over time. Fatigue is one of the most common problems faced in modern life by men, women, as well as children. It is very well-known in the communities and regular complaint in primary care clinics including acute and chronic

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REFERENCES

- Aziz, A.A., and Klein, M.C.A. (2010). Design of an intelligent support agent model for people with a cognitive vulnerability. *IEEE Computer Society Press*, 285-290.
- Afari, N., & Buchwald, D. (2003). Chronic fatigue syndrome: A review. *Psychiatry*, 160, 221–236.
- Arnold, J. A., Robertson, I. T., & Cooper, C. L. (1991). *Work Psychology: Understanding human behaviour in the workplace*. London: Pitman Publishing.
- Bagnall, A., Whiting, P., Richardson, R., & Sowden, A. (2002). Interventions for the treatment and management of chronic fatigue syndrome/myalgic encephalomyelitis. *Qual Saf Health Care*, 11, 284–288.
- Barofsky, I., West, M. (1992). Definition and measurement of fatigue. *Rev Infect Dis*, 13, S94–S97.
- Bombardier, C., Buchwald, D. (1996). Chronic fatigue, chronic fatigue syndrome, and fibromyalgia: disability and health-care use. *Med Care*, 34, 924-930.
- Buchwald, D., Pascualy, R., Bombardier, C., & Kith, P. (1994). Sleep disorders in patients with chronic fatigue. *Clinical Infectious Diseases*, 18, S68-S72.
- Buchwald, D., Umali, P., & Umali, J. (1995). Chronic fatigue and the chronic fatigue syndrome: prevalence in a Pacific Northwest health care system. *Ann Intern Med*, 123, 81-88.
- Burnet, R., Chatterton, B. (2004). Gastric emptying is slow in chronic fatigue syndrome. *BMC Gastroenterology*, 4, 32.
- Carruthers, M., Kumar Jain, A., & De Meirleir, K. (2003). Myalgic encephalomyelitis/chronic fatigue syndrome: clinical working case definition, diagnostic and treatment protocols. *Journal of Chronic Fatigue Syndrome*, 11(1), 7–115.

- Chalder, T., Berelowitz, G., Pawlikowska, T., Watts, L., Wessely, S., Wright, D., & Wallace, E. P. (1993). Development of a fatigue scale. *Journal of Psychosomatic Research*, 37(2), 147–153.
- Christley, Y., Duffy, T., & Martin, C. (2010). A review of the definitional criteria for chronic fatigue. *Journal of Evaluation in Clinical Practice*, 18 25–31.
- Cleare, A. J. (2004). The HPA axis and the genesis of chronic fatigue syndrome. *TRENDS in Endocrinology and Metabolism*, 15(2).
- Coggon, D., Martyn, C., Palmer, K. T. & Evanoff, B. (2005). Assessing case definitions in the absence of a diagnostic gold standard. *International Journal of Epidemiology*, 34 (4), 949–952
- Courjaret, J., Schotteb, C., Wijnantsc, H., Moorkensc, G., & Cosyns, P. (2009). Chronic fatigue syndrome and DSM-IV personality disorders. *Journal of Psychosomatic Research*, 66 13–20.
- Deale, A. (1997). Cognitive Behavior Therapy for Chronic Fatigue Syndrome: A Randomized Controlled Trial. *Am J Psychiatry*, 3, 154.
- Deary, V. (2004). *Chronic fatigue and chronic fatigue syndrome – a practical self help site*. Retrieved from : <http://www.kcl.ac.uk/cfs>
- Dick, M., & Sundin, J. (2003). Psychological and psychiatric causes of fatigue. *Australian Family Physician*, 32(11).
- Edwards, J., Rothbard, N. (1999). Work and family stress and well-Being: An Examination of person–environment fit in the work and family domains. *Journal of Organizational Behavior and Human Decision Processes*. 77, 85-129.
- Emerson, E., Remington, B., C., & Hastings, R. P. (1995). Special issue on staffing. *Mental Handicap Research*, 8, 215–339.
- Evengaerd, B., Sshacterle, R., & Komaroff, A. (1999). Chronic fatigue syndrome: new insights and old ignorance. *Journal of Internal Medicine*(246), 455 - 469.

- Fernández, A., Martín,A., Martínez,M., Bustillo, M., Hernández, F., Labrado,J., Peñas,R., Rivas,E., Delgado,C., Redondo,J., and Ramón J., & Giménez11, R. (2009). Review chronic fatigue syndrome: aetiology, diagnosis and treatment. *BMC Psychiatry*, 9(1), 1.
- Friedberg, F. (2009). Cognitive-Behavior Therapy in chronic fatigue syndrome: Is improvement related to increased physical activity? *Journal of Clinical Psychology* , 65(4), 1-20.
- Fukuda, K., Straus, E., Hickie, I., Sharpe, C., Dobbins, G. & Komaroff, A. (1994). Chronic fatigue syndrome: a comprehensive approach to its definition. *Ann. Intern. Med*(121), 953–959.
- Greiner, B. A., Ragland, D. R., Krause, N., Syme, S. L., & Fisher, J. M. (1997). Objective measurement of occupational stress factors - An example with San Francisco urban transit operators. *Journal of Occupational Health Psychology*, 2, 325-342.
- Gibson, M. (1993). Stress in the workplace: A hidden cost factor. *HR Focus*, 70.
- Goodnick, P. J. (2001). *Chronic Fatigue and Related Immune Deficiency Syndromes*. Washington, DC.
- Hamilton, W., Hall, G., & Round,A. (2001). Frequency of attendance in general practice and symptoms before development of chronic fatigue syndrome: a case-control study. *British Journal of General Practice*, 51, 553-558.
- Hartz, A. J., Kuhn, E. M., & Levine, P. (1998). Characteristics of fatigued persons associated with features of chronic fatigue syndrome. *Journal of Chronic Fatigue Syndrome*, 4(3), 71–97.
- Harvey, S., Wadsworth,M., Hotopf, M. & Wessely, S. (2008). The relationship between prior psychiatric disorder and chronic fatigue: evidence from a national birth cohort study. *Psychol Med*, 38(7), 933–940.
- Harvey, S., Wessely, S. (2009). Chronic fatigue syndrome: identifying zebras amongst the horses. *BMC Med* 7(58).
- Harvey, S., & Wessely,S. (2009). Commentary Open Access Chronic fatigue syndrome: identifying zebras amongst the horses. *BMC Medicine*, 7, 58.

- Hempel, S., Chambers, D., Bagnall, A., & Forbes, C. (2007). Risk factors for chronic fatigue syndrome/myalgic encephalomyelitis: a systematic scoping review of multiple predictor studies. *Psychological Medicine*, 1-12.
- Holmes, p., Kaplan, E., Gantz, M., Komaroff, L., Schonberger, B., Straus, E., Jones, F., Dubois, E., Cunningham, R., & Pahwa, S. (1988). Chronic fatigue syndrome: a working case definition. *Annals of Internal Medicine*, 108 (3), 387–389.
- Holmes, p. (1991). Defining the chronic fatigue syndrome. *Reviews of Infectious Diseases*, 13(1), S53–S55.
- Jason, L., Richman, J., Rademaker, A., Plioplys, A., Taylor, R., McCready, W., & Huang, C. (1999). A Community-based study of chronic fatigue syndrome. *ARCH INTERN MED*, 159, 21-30.
- Jason, L., Taylor, R., & Carrico, A. (2001). A community –based study of seasonal variation in the onset of chronic fatigue syndrome and idiopathic chronic fatigue. *Chronobiology International*, 18(2), 315–319.
- Kai-Wen, C. (2010). A study of stress sources among college students in Taiwan. *Journal of Academic and Business Ethics*, 1-6.
- Kato, K., Sullivan, P., Evengard, B., Pedersen, N. (2006). Premorbid predictors of chronic fatigue. *Arch Gen Psychiatry*, 63.
- Kawakami, N., Iwata, N., Fujihara, S. (1998). Prevalence of chronic fatigue syndrome in a community population in Japan. *Tohoku J Exp Med* 186, 33-41.
- Kocalevent, R., Hinz, A., Brähler, E., & Klapp, B. (2011). Determinants of fatigue and stress. *BMC Research Notes*, 4, 238.
- Klimas, N. G. (2007). Chronic fatigue syndrome: inflammation, immune function, and neuroendocrine interactions. *Medicine Group LLC*.
- Lin, J., Resch, S., Brimmer, D., Johnson, A., Kennedy, S., Burstein, N., & Simon, C. (2008). The economic impact of chronic fatigue syndrome in Georgia: direct and indirect costs. *Cost Effectiveness and Resource Allocation*, (9), 1.

- Lyall, M., Peakman, M., Wessely, S. (2002). A systematic review and critical evaluation of the immunology of chronic fatigue syndrome. *Journal of Psychosomatic Research*, 55, 79–90.
- Maes, M., & Twisk, F. (2011). Chronic fatigue syndrome: Harvey and Wessely's (bio) psychosocial model versus a bio(psychosocial) model based on inflammatory and oxidative and nitrosative stress pathways. *BMC Medicine* 8, 35.
- Manu, P., Lane, T. J., & Matthews, D. A. (1988). The frequency of the chronic fatigue syndrome in patients with symptoms of persistent fatigue. *Annals of Internal Medicine*, 109, 554 – 556.
- Morinet, F., and Corruble, E. (2005). Chronic Fatigue Syndrome and Viral Infections. *Center of Innovative Therapy in Oncology and Hematology*, 12.
- Moustaka, E. (2010). Sources and effects of Work-related stress in nursing. *Health Science Journal*, 4(4), 210-216.
- Nater, U., Jones, J., Lin, J., Maloney, E., Reeves, W., Heim, C. (2010). Personality features and personality disorders in chronic fatigue syndrome: A Population-Based Study. *Psychother Psychosom*, 79, 312–318.
- Nisenbaum, R., Reyes, M., Mawle, A. C., & Reeves, W. (1998). Factor analysis of unexplained severe fatigue and interrelated symptoms. *American Journal of Epidemiology*, 148(1), 72–77.
- Olivadoti, M. (2007). Sleep and fatigue during chronic viral infection.
- Palmer, S., Cooper, C., & Thomas, K. (2003). Revised model of organisational stress for use within stress prevention/management and wellbeing programmes – brief update. *International Journal of Health Promotion and Education*, 41(2), 8-57.
- Palmer, S., Cooper, C., & Thomas, K. (2001). Model of organisational stress for use within an occupational health education/promotion or wellbeing programme – a short communication. *Health Education Journal*, 60(4), 78-80.

- Palmer, S., Cooper, C., & Thomas, K. (2004). A model of work stress to underpin the Health and Safety Executive advice for tackling work-related stress and stress risk assessments. *Centre for Stress Management*. .
- Patarca-Montero, R. (2003). *Chronic Fatigue Syndrome, Genes, and Infection: The Eta-1/Op Paradigm*. Binghamton: The Haworth Medical Press.
- Prins, J., & Bleijenberg, G. (1999). Cognitive behavior therapy for chronic fatigue syndrome: a case study. *Journal of Behavior Therapy and Experimental Psychiatry*, 30, 325-339.
- Ray, C., Weir, R. C., Cullen, S., & Phillips, S. (1992). Illness perception and symptom components in chronic fatigue syndrome. *Journal of Psychosomatic Research*, 36(3), 243–256.
- Rees, C. J. (2000). Recognising the perceived causes of stress a training and development perspective. *Industrial and Commercial Training*, 32(4), 120 -127.
- Reyes, M., Nisenbaum, R., Hoaglin, D.C., Unger, E.R., Emmons, C., Randall, B., Stewart, J.A., Abbey, S., Jones, J.F., Gantz, N., Minden, S., & Reeves, W.C. (2003). Prevalence and incidence of chronic fatigue syndrome in Wichita, Kansas. *Arch. Intern. Med*, 163, 1530-1536.
- Reynolds, K., Vernon, S., Bouchery, E. & Reeves, W. (2004). The economic impact of chronic fatigue syndrome. *Cost Effectiveness and Resource Allocation* (2), 4.
- Robbins, S. P., & Judge, T.A. (2009). *Organizational behavior* (13ed.). New Jersey: Pearson Prentice Hall Inc.
- Rose, J., Mullan, E., & Fletcher, B. (1994). An examination of the relationship between staff behavior and stress levels in residential care. *Mental Handicap Research*, 7, 312–328.
- SafetyNet. (2009). Fatigue.
- Sharpe, M., Archard, L., Banatvala, J., Borysiewicz, L., Clare, A., David, A., Edwards, R., Hawton, K., Lambert, H. & Lane, R. (1991). A report – chronic fatigue syndrome: guidelines for research. *Journal of the Royal Society of Medicine*, 84 (2), 118–121.

- Sivonova, M., Zitnanova, I., Hlincikova, L., Skodacek, I., Trebaticka, J., Durackova, Z. (2004). Oxidative stress in university students during examinations. *Stress* 7, 183-188.
- Smets, E., Garssen, B., Bonke, B., DeHaes, J. (1995). The multidimensional fatigue inventory (MFI) psychometric qualities of an instrument to assess fatigue. *J Psychosom Res* 39, 315-325.
- Song, S., Jason, L. (2005). A population-based study of chronic fatigue syndrome (CFS) experienced in differing patient groups: An effort to replicate Vercoulen et al.'s model of CFS. *Journal of Mental Health*, 3(14), 277 – 289
- Sonnentag, S. & Fay, D., (2001). *Stressors and personal initiative: A study on organizational behavior*.
- Stein, E. (2005). Assessment and Treatment of Patients with ME/CFS: Clinical Guidelines for Psychiatrists. *Psychiatric Treatment Guidelines E. Stein*.
- Stephen, P., Thomas, C.(2004). A model of work stress to underpin the health and safety executive advice for tackling work-related stress and stress risk assessments. *Centre for Stress Management*, 3, 14 - 27.
- Straus, S. E. (1992). Defining the chronic fatigue syndrome. *Archives of Internal Medicine*, 8(152), 1569–1570.
- Susan, T. & Jason A., (2005). What is fatigue? History and Epidemiology.
- Vercoulen, J., Swanink, C., Galama, J., Fennis, J., Jongen, P., Hommes, O., van, J., Bleijenberg, G. (1998). The persistence of fatigue in chronic fatigue syndrome and multiple sclerosis: development of a model. *J Psychosom Res* 45, 507-517.
- Volpe, J. F. (2000). A guide to effective stress management. *Career and Technical Education*, 48(10), 183-188.
- Watson, D., & Pennebaker, W. (1989). Health complaints, stress and distress: Exploring the central role of negative affectivity. *Psychological Review*, 96, 234–254.

- Watt, T., Groenvold, M., Bjorner, J., Noerholm, V., Rasmussen, N., & Bech, P. (2000). Fatigue in the Danish general population. Influence of sociodemographic factors and disease. *Epidemiol Community Health* 54, 827–833.
- Werf, S. Prins, J., Vercoulen, J., Meer, J. & Bleijenberg, G. (2000). Identifying physical activity patterns in chronic fatigue syndrome using actigraphic assessment. *Journal of Psychosomatic Research*, 49, 373 – 379.
- Wessely, S., Chalder, S., Hirsch, S., Wallace, P., & Wright, D. (1997). The prevalence and morbidity of chronic fatigue and chronic fatigue syndrome: a prospective primary care study. *Am J Publications Health* 9(4), 49-55.
- Wessely, S. (1998). The epidemiology of chronic fatigue syndrome. *Epidemiologia e Psichiatria Sociale*, 7(1), 10–24.
- White, C., & Sweitzer, R. . (2000). The role of personality in the development and perpetuation of chronic fatigue syndrome. *Journal of Psychosomatic Research*, 48, 515–524.
- Wiborg, J., Knoop, H., Stulemeijer, M., Prins, J., Bleijenberg, G.(2010). How does cognitive behaviour therapy reduce fatigue in patients with chronic fatigue syndrome? The role of physical activity. *Psychol Med*, 5,1-7.
- Wiley, J. (1993). *Chronic Fatigue Syndrome* (1 ed.). West Sussex, England: John Wiley & Sons Ltd.
- Wilson, A., Hickie, I., Lloyd, A., Boughton, C., Dwyer,J., and Wakefield, D. (1994). Longitudinal study of outcome of chronic fatigue syndrome. *BMJ*, 308.
- Zapf, D., Dormann, C., & Frese, M. (1996). Longitudinal studies in organizational stress research: A review of the literature with reference to methodological issues. *Journal of Occupational Health Psychology*, 1, 145-169.