

CHAPTER IV

RESULTS

1. Comparing for three mode between normal and obese groups

Table 4 Comparison of the temporospatial and kinematic variables between normal and obese groups during overground walking (Values are mean \pm SD)

Variables	Normal weight group (n = 10)	Obese group (n = 10)	<i>p</i> value
Step length (m)	0.63 \pm 0.05	0.60 \pm 0.06	0.351
Cadence (steps/minute)	116.40 \pm 11.37	106.80 \pm 16.56	0.148
Stance cycle (% of gait cycle)	64.76 \pm 1.15	66.20 \pm 2.06	0.70
Trunk angle at initial contact (°)	-7.10 \pm 1.78	-6.18 \pm 4.44	0.549
Hip angle at initial contact (°)	21.59 \pm 4.13	18.22 \pm 4.69	0.105
Knee angle at initial contact (°)	4.08 \pm 5.61	0.84 \pm 5.07	0.192
Ankle angle at initial contact (°)	-10.10 \pm 4.60	-8.45 \pm 4.61	0.433
Maximum trunk flexion angle during swing phase (°)	-6.28 \pm 1.53	-6.82 \pm 3.86	0.687
Maximum hip flexion angle during swing phase (°)	27.29 \pm 2.69	23.23 \pm 5.05	0.038*

Table 4 (Continuous)

Variables	Normal weight group (n = 10)	Obese group (n = 10)	p value
Maximum knee flexion angle during swing phase (°)	71.08 ± 4.05	65.91 ± 5.61	0.030*
Maximum ankle flexion angle during swing phase (°)	-4.96 ± 4.03	-4.25 ± 5.03	0.731
Maximum hip extension angle during stance phase (°)	13.24 ± 2.82	15.91 ± 3.80	0.091

* Significant difference at $p < 0.05$, obese group VS. normal weight group

Temporospatial variables and kinematics variables during various phases of gait cycle for overground walking. Student t-tests compared values between the normal weight and obese groups.

The mean, standard deviations (SD) and statistical results for overground walking are presented in Table 4. During overground walking, the obese group had lesser maximum hip flexion angle ($p = 0.038$) and maximum knee flexion angle ($p = 0.030$) during swing phase than the normal weight group.

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Table 5 Comparison of the temporospatial and kinematic variables between normal and obese groups during treadmill walking (Values are mean \pm SD)

Variables	Normal weight group (n = 10)	Obese group (n = 10)	p value
Step length (m)	0.57 \pm 0.03	0.51 \pm 0.03	0.001*
Cadence (steps/minute)	127.61 \pm 9.30	125.56 \pm 19.03	0.764
Stance cycle (% of gait cycle)	65.36 \pm 0.86	67.45 \pm 1.76	0.003*
Trunk angle at initial contact (°)	3.52 \pm 2.40	3.20 \pm 4.503	0.846
Hip angle at initial contact (°)	20.80 \pm 4.26	16.15 \pm 4.53	0.029*
Knee angle at initial contact (°)	6.14 \pm 7.63	1.83 \pm 6.97	0.204
Ankle angle at initial contact (°)	-6.76 \pm 2.76	-5.96 \pm 6.39	0.718
Maximum trunk flexion angle during swing phase (°)	-3.39 \pm 2.54	-3.28 \pm 4.32	0.554
Maximum hip flexion angle during swing phase (°)	26.71 \pm 3.22	22.10 \pm 4.36	0.015*
Maximum knee flexion angle during swing phase (°)	71.58 \pm 4.92	65.12 \pm 4.06	0.005*
Maximum ankle flexion angle during swing phase (°)	-3.80 \pm 3.04	-4.39 \pm 6.37	0.793

Table 5 (Continuous)

Variables	Normal weight group (n = 10)	Obese group (n = 10)	p value
Maximum hip extension angle during stance phase (°)	15.14 ± 2.34	18.21 ± 3.52	0.34

* Significant difference at $p < 0.05$, obese group VS. normal weight group

Table 5 showed mean, standard deviations (SD) and statistical results of temporospatial variables and joint kinematics for 0% treadmill walking.

The obese group presented lesser step length ($p = 0.001$), longer stance cycle ($p = 0.003$), lesser hip joint angle at initial contact ($p = 0.029$), and lesser maximum hip flexion angle ($p = 0.015$) and maximum knee flexion angle ($p = 0.005$) during swing phase than the normal weight group at treadmill 0% walking.

Table 6 Comparison of the temporospatial and kinematic variables between normal and obese groups during treadmill 10% walking (Values are mean \pm SD)

Variables	Normal weight group (n = 10)	Obese group (n = 10)	p value
Step length (m)	0.55 \pm 0.07	0.52 \pm 0.06	0.367
Cadence (steps/minute)	133.91 \pm 18.01	123.00 \pm 16.87	0.179
Stance cycle (% of gait cycle)	65.73 \pm 1.04	67.30 \pm 2.00	0.041*
Trunk angle at initial contact (°)	-0.73 \pm 3.03	-2.58 \pm 6.15	0.403
Hip angle at initial contact (°)	33.85 \pm 4.03	27.56 \pm 4.97	0.006*
Knee angle at initial contact (°)	26.94 \pm 7.16	16.64 \pm 6.98	0.004*
Ankle angle at initial contact (°)	0.30 \pm 2.96	-1.58 \pm 7.05	0.445
Maximum trunk flexion angle during swing phase (°)	1.33 \pm 2.88	2.63 \pm 6.22	0.554
Maximum hip flexion angle during swing phase (°)	34.64 \pm 3.57	28.79 \pm 4.79	0.006*
Maximum knee flexion angle during swing phase (°)	69.15 \pm 6.11	61.46 \pm 4.48	0.005*
Maximum ankle flexion angle during swing phase (°)	2.15 \pm 3.15	-0.79 \pm 7.13	0.248

Table 6 (Continuous)

Variables	Normal weight group (n = 10)	Obese group (n = 10)	p value
Maximum hip extension angle during stance phase (°)	15.47 ± 2.56	18.26 ± 3.06	0.040*

* Significant difference at $p < 0.05$, obese group VS. normal weight group

The means, standard deviations (SD) and statistical results for treadmill 10% walking are demonstrated in Table 6.

The obese group presented longer stance cycle ($p = 0.041$), lesser hip joint angle ($p = 0.006$) and knee joint angle ($p = 0.004$) at initial contact, lesser maximum hip flexion angle ($p = 0.006$) and maximum knee flexion angle ($p = 0.005$) during swing phase and greater maximum hip extension angle during stance phase ($p = 0.040$) than the normal weight group at treadmill 10% walking.

2. Comparing within group between three walking modes

Table 7 Summary of temporospatial and joint kinematic variables for the normal group at three modes of walking

Variables	Mode		
	Overground	Treadmill 0%	Treadmill 10%
Step length (m)	0.63 ± 0.05 ^{ab}	0.57 ± 0.03 ^a	0.55 ± 0.07 ^b
Cadence (steps/minute)	116.40 ± 11.37 ^{ab}	127.61 ± 9.30 ^a	133.91 ± 18.01 ^b
Stance cycle (% of gait cycle)	64.76 ± 1.15 ^b	65.36 ± 0.86	65.73 ± 1.04 ^b
Trunk angle at initial contact (°)	7.10 ± 1.78 ^{ab}	3.52 ± 2.40 ^{ac}	-0.73 ± 3.03 ^{bc}
Hip angle at initial contact (°)	21.59 ± 4.13 ^b	20.80 ± 4.26 ^c	33.85 ± 4.03 ^{bc}
Knee angle at initial contact (°)	4.08 ± 5.61 ^b	6.14 ± 7.63 ^c	26.94 ± 7.16 ^{bc}
Ankle angle at initial contact (°)	-10.10 ± 4.60 ^{ab}	-6.76 ± 2.76 ^{ac}	0.30 ± 2.96 ^{bc}
Maximum trunk flexion angle during swing phase (°)	-6.28 ± 1.53 ^{ab}	-3.39 ± 2.54 ^{ac}	1.33 ± 2.88 ^{bc}
Maximum hip flexion angle during swing phase (°)	27.29 ± 2.69 ^b	26.71 ± 3.22 ^c	34.64 ± 3.57 ^{bc}

Table 7 (Continuous)

Variables	Mode		
	Overground	Treadmill 0%	Treadmill 10%
Maximum knee flexion angle during swing phase (°)	71.08 ± 4.05	71.58 ± 4.92 ^c	69.15 ± 6.11 ^c
Maximum ankle flexion angle during swing phase (°)	-4.96 ± 4.03 ^b	-3.80 ± 3.04 ^c	2.15 ± 3.15 ^{bc}
Maximum hip extension angle during stance phase (°)	13.24 ± 2.82 ^b	15.14 ± 2.34	15.47 ± 2.56 ^b

Means sharing same letters differ significantly ($p < 0.05$)

a: significance between overground and treadmill 0%

b: significance between overground and treadmill 10%

c: significance between treadmill 0% and treadmill 10%

The mean and standard deviations (SD) of three walking modes for normal weight group are presented in table 7.

When comparing in normal weight group found significant differences in step length and cadence between overground and treadmill 0% walking, and overground and treadmill 10% walking. Moreover, there were significance differences in stance cycle between overground and treadmill 10% walking.

At initial contact, significant differences were found in trunk angle and ankle joint angle between overground and treadmill 0% walking, overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking, although, hip and knee joint angle found statistical differences between overground and treadmill 0% walking, and treadmill 0% and treadmill 10% walking.

During swing phase, first, there were significant differences in maximum trunk flexion angle between overground and treadmill 0% walking, overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking. Second, significant differences were found for maximum hip and ankle flexion angle between overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking. Last, there was significant difference in maximum knee flexion angle between treadmill 0% and treadmill 10% walking.

Last, there were significant differences in maximum hip extension angle during stance phase between overground and treadmill 10% walking.

Table 8 Summary of temporospatial and joint kinematics variables for obese groups at three mode of walking

Variables	Mode		
	Overground	Treadmill 0%	Treadmill 10%
Step length (m)	0.60 ± 0.06 ^{ab}	0.51 ± 0.03 ^a	0.52 ± 0.06 ^b
Cadence (steps/minute)	106.80 ± 16.56 ^{ab}	125.56 ± 19.03 ^a	123.00 ± 16.87 ^b
Stance cycle (% of gait cycle)	66.20 ± 2.06 ^a	67.45 ± 1.76 ^a	67.30 ± 2.00
Trunk angle at initial contact (°)	6.18 ± 4.44 ^{ab}	3.20 ± 4.53 ^{ac}	-2.58 ± 6.15 ^{bc}
Hip angle at initial contact (°)	18.22 ± 4.69 ^{ab}	16.15 ± 4.53 ^{ac}	27.56 ± 4.97 ^{bc}
Knee angle at initial contact (°)	0.84 ± 5.07 ^b	1.83 ± 6.97 ^c	16.64 ± 6.98 ^{bc}
Ankle angle at initial contact (°)	-8.45 ± 4.61 ^{ab}	-5.96 ± 6.39 ^{ac}	-1.58 ± 7.05 ^{bc}
Maximum trunk flexion angle during swing phase (°)	-6.82 ± 3.86 ^{ab}	-3.28 ± 4.32 ^{ac}	2.63 ± 6.22 ^{bc}
Maximum hip flexion angle during swing phase (°)	23.23 ± 5.05 ^b	22.10 ± 4.36 ^c	28.79 ± 4.79 ^{bc}
Maximum knee flexion angle during swing phase (°)	65.91 ± 5.61 ^b	65.12 ± 4.06 ^c	61.46 ± 4.48 ^{bc}
Maximum ankle flexion angle during swing phase (°)	-4.25 ± 5.03 ^b	-4.39 ± 6.37 ^c	-0.79 ± 7.13 ^{bc}

Table 8 (Continuous)

Variables	Mode		
	Overground	Treadmill 0%	Treadmill 10%
Maximum hip extension angle during stance phase (°)	15.91 ± 3.80 ^{ab}	18.21 ± 3.52 ^a	18.26 ± 3.06 ^b

Means sharing same letters differ significantly ($p < 0.05$)

a: significance between overground and treadmill 0%

b: significance between overground and treadmill 10%

c: significance between treadmill 0% and treadmill 10%

Table 8 showed mean and standard deviations (SD) of three walking modes for obese group.

In temporospatial variables of obese group, it was found that there were significant differences in step length and cadence between overground and treadmill 0% walking, and overground and treadmill 10% walking. Moreover, significant differences were found for stance cycle between overground and treadmill 0% walking.

At initial contact, the data showed that there were significant differences in trunk angle, hip joint angle and ankle joint angle between overground and treadmill 0% walking, overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking. Knee joint angle found significant differences between overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking.

During swing phase of obese group, it was found that there were significant differences in maximum trunk flexion angle between overground and treadmill 0% walking, overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking. Moreover, there were significant differences for maximum hip, knee and ankle flexion angle between overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking.

Last, there were significant differences in maximum hip extension angle during stance phase between overground and treadmill 0% walking and overground and treadmill 10% walking for obese participants.

Hip joint angle at initial contact was not statistically significant different between groups at overground walking. However, the normal groups had greater hip joint angle at initial contact than the obese groups in treadmill 0% and treadmill 10% walking.

When comparing between modes of walking, for the normal weight group, significant differences were found for hip joint angle at initial contact between overground and treadmill 0% walking and treadmill 0% and treadmill 10% walking. In obese group, there was significant different between overground and treadmill 0% walking, overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking for hip joint angle at initial contact.

The normal weight group tended to have greater knee joint angle at initial contact than the obese group at overground and treadmill 0% walking but there were no statistical different between groups. At treadmill 10% walking, the normal weight group demonstrated greater knee joint angle at initial contact than the obese group.

When comparing between modes of walking for knee joint angle at initial contact, both groups were statistically significant different between overground and treadmill 0% walking, overground and treadmill 10% walking, and treadmill 0% and treadmill 10% walking.

Trunk, hip, knee and ankle joint angle for overground, treadmill 0% and treadmill 10% walking are presented in figure 5 - 8. The graphical representations are presented by only 1 obese participant and 1 normal weight participant. However, the pattern of trunk, hip, knee and ankle flexion-extension for obese participant showed the similar pattern as in normal weight participant at three modes of walking.

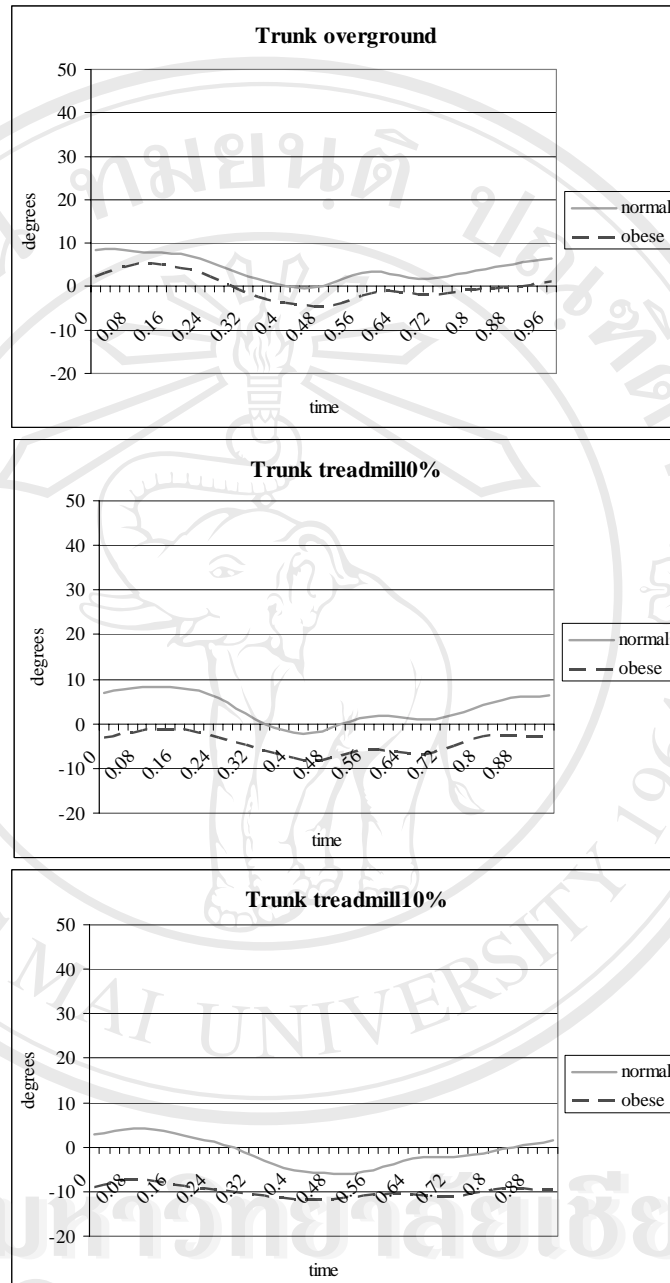


Fig 5 Trunk flexion-extension pattern

- a. overground walking
- b. treadmill 0% walking
- c. treadmill 10% walking

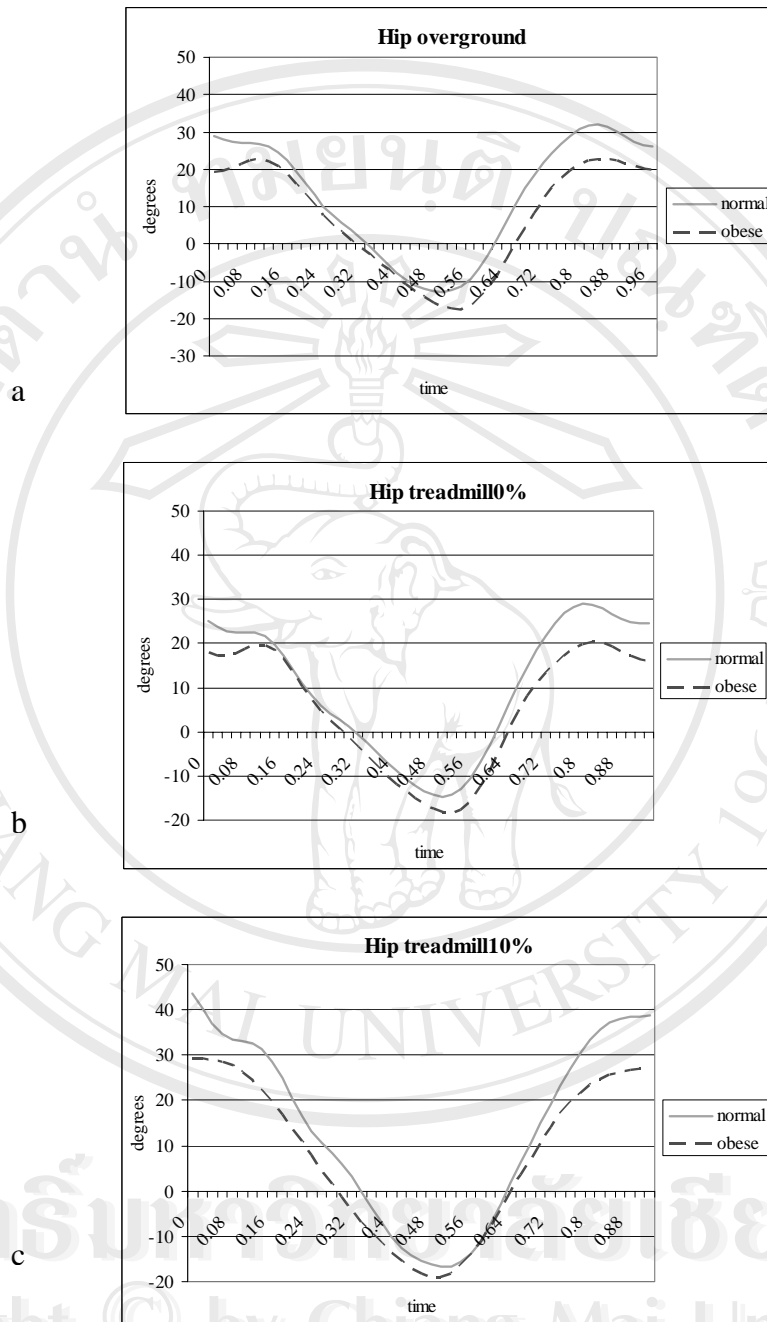


Fig 6 Hip flexion-extension pattern

- a. overground walking
- b. treadmill 0% walking
- c. treadmill 10% walking

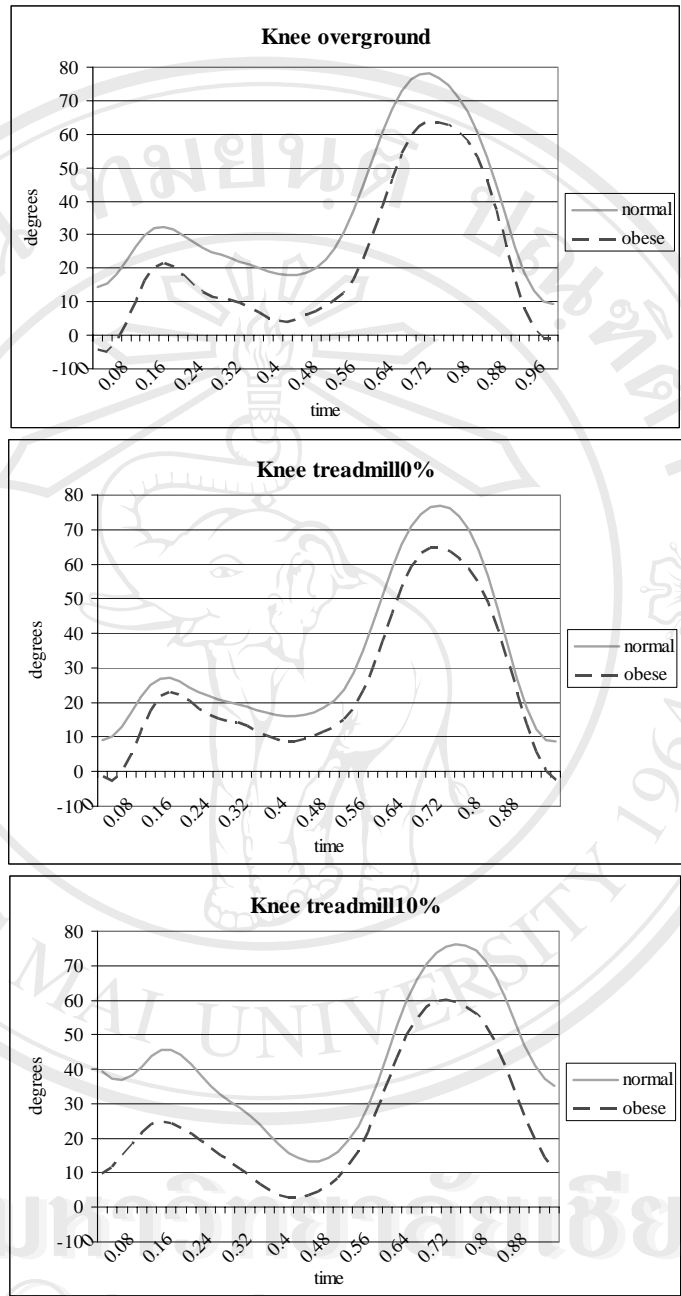


Fig 7 Knee flexion-extension pattern

- a. overground walking
- b. treadmill 0% walking
- c. treadmill 10% walking

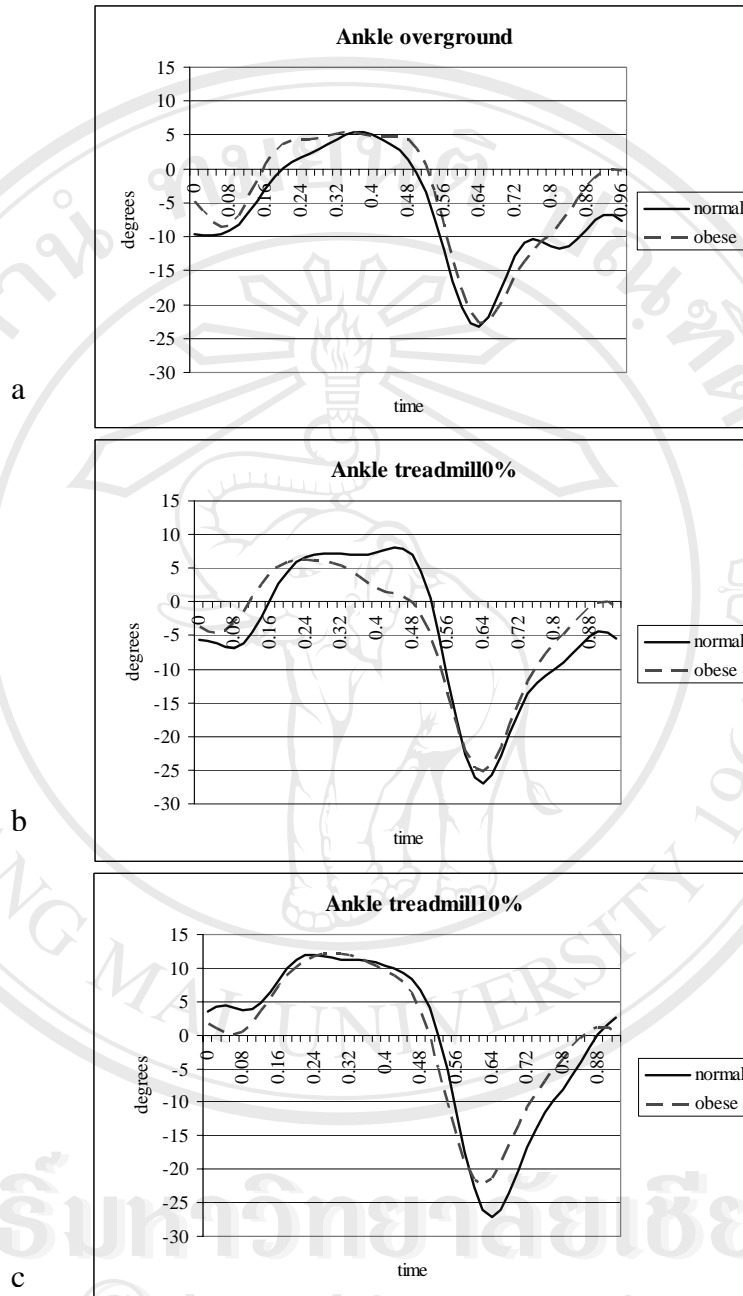


Fig 8 Ankle dorsiflexion-plantarflexion pattern

- a. overground walking
- b. treadmill 0% walking
- c. treadmill 10% walking